Nordic guide to sustainable materials

WP 2: The criteria

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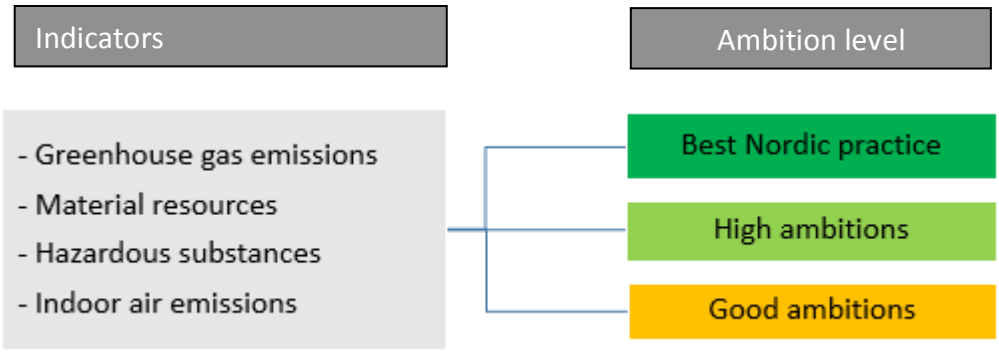
Summary

We have chosen four indicators to describe the sustainability of building materials. These indicators are Global warming potential, Material resources, Hazardous substances and Emissions to indoor climate.

The sustainability ambitions of building materials are basically split into three levels, based on type of documentation and achieved quality. The most ambitious level for each of the four indicators is based on the best practice in one or several of the four Nordic countries.



The level "Best Nordic practice" is represented by given levels based on standardized verified declaration. The level "High ambitions" is represented by standardized verified declaration, while the level "Good ambitions" is represented by self-declaration. EPDs and other well know Nordic declaration systems are central documentation to confirm that the various ambition levels are achieved.

For some product groups it is either not enough data to establish the most ambitious level or the consequences of the environmental impact on a building level is so low that the highest ambitions are omitted. For the product with lacking data as a basis, the most ambitious level corresponds to the same requirements as the High ambition to stimulate more verified environmental declaration.

The most ambitious level of indoor emissions is according to the low emission level in EN 15251.

Table 1. Criteria for the "Best Nordic practise" in 2016 for all four indicators

	Greenhouse gases	Resources [2]	Hazardous substances	Indoor emissions
All wood based materials [1]	Depending on product group	Certified/no tropical [4]	Depending on product group	Depending on product group
Concrete, C30	200 kg CO_2-eqv/m^3	> 5 %	< 0,1 % Reach cand. list	
Concrete, C35	220 kg CO_2-eqv/m^3	> 5 %	< 0,1 % Reach cand. list	
Concrete, C45	240 kg CO_2-eqv/m^3	> 5 %	< 0,1 % Reach cand. list	
Steel reinforcement	0,6 kg CO_2-eqv/tonn	> 95 %	Defined level for given substances	
Concrete slab elements	Verified documentation	> 5 %	< 0,1 % Reach cand. list	
Steel constructions	Verified documentation	> 20 %	Defined level for given substances	
Wooden constructions	Verified documentation	Certified/no tropical [4]	Defined level for given substances	
Windows (60 years)	160 kg CO_2-eqv/window, alt. 2,5 CO_2-ekv pr kg	> 0 %	Defined level for given substances	
Insulation				
Mineral wool	1,5 kg CO_2-eqv/m^2 and R=1	> 20 %	Defined level for given substances	
EPS	2,5 kg CO_2-eqv/m^2 and R=1	-		
XPS	5,0 kg CO_2-eqv/m^2 and R=1			
Others	Verified documentation			
Outdoor cladding	Verified documentation	> 0 %	Defined level for given substances	
Outdoor paints			Defined level for given substances	
Roofing	5 CO_2-eqv/m^2	> 0 %	Defined level for given substances	
All indoor building boards [3,4]	3,0 kg CO_2-ekv pr m^2, alt. 0,30 CO_2-ekv pr kg	> 0 %	Defined level for given substances	Low emission
Gypsum boards		> 30 %		Low emission
Indoor paints and varnishes			Defined level for given substances	Low emission
Floor coverings				
Carpets	Verified documentation	> 40 %	Defined level for given substances	Low emission
Vinyl and linoleum		> 15 %		
Others				
Ceilings		> 0 %	Defined level for given substances	Low emission
Adhesives			Defined level for given substances	Low emission
Sealants			Defined level for given substances	Low emission
Screeds			Defined level for given substances	Low emission

[1] All wooden based products (like wood constructions, building boards, windows, ceilings, floors, etc).
[2] The percentage relates to the amount of secondary resources used in the product
[3] Wooden constructions as glulam, massive wood etc.
[4] Wooden based building boards must be certified and not come from tropical forests

The “Best Nordic practice” criteria for specific Hazardous substances are described in Table 2.

Table 2. Criteria for the two most ambitious levels for different Hazardous substances

	Best Nordic practice	**High ambitions**
H350 Carc. 1A or 1B	≤ 0,01 %	< 0,1%
H351 Carc. 1A or 1B	≤ 0,01 %	< 0,1%
H340 Muta. 1A or 1B	≤ 0,01 %	< 0,1%
H341 Muta. 2	≤ 0,1 %	1 %
H360 Repr. 1A or 1B	≤ 0,01 %	0,5 (0,1) %
H361	≤ 0,3 %	5 (3) %
H362 Lact	≤ 0,03 %	0,3 (0,1) %
Endocrine disruptors	≤ 0,01 %	< 0,1%
PBT	≤ 0,01 %	< 0,1%
vPvP	≤ 0,01 %	< 0,1%
Lead and compounds of lead	≤ 0,01 %	< 0,1%
Mercury and compounds of mercury	Prohibited	< 0,1%
Cadmium and compounds of cadmium	≤ 0,001 %	< 0,01%
H420 Harmful to the ozone layer	≤ 0,01 %	< 0,1%
Brominated flame retardants	< 0,1%	< 0,1%
H334 Resp	≤ 0,02 %	< 0,2 %
H317 Skin	≤ 0,1 %	< 1 %
H300 Acute Tox. 1	≤ 0,01 %	< 0,1%
H300 Acute Tox. 2	≤ 0,1 %	< 0,1%
H301 Acute Tox	≤ 1 %	< 3%
H310 Acute Tox. 1	≤ 0,01 %	< 0,1%
H330 Acute Tox. 1		< 0,1%
H311 Acute Tox	≤ 1 %	< 3%
H331 Acute Tox		< 3%
H370 STOT SE 1	≤ 0,1 %	< 1%
H371 STOT SE 2	≤ 1 %	< 25%
H372 STOT RE 1	≤ 0,1 %	< 1%
H373 STOT RE 2	≤ 1 %	< 25%
H400 Aqau Acute 1	≤ 2,5 %	< 25%
H410 Aqua Chronic 1	≤ 0,25 %	< 2,5%
H411 Aqua Chronic 2	≤ 2,5 %	< 25%
H413 Aqua Chronic 4	≤ 2,5 %	< 25%
H360 Repr. 1A	≤ 0,01 %	0,5 %

1. Introduction

1.1. Background

In the "Nordic Guide to Sustainable Materials" project, the Green Building Councils (GBCs) in Norway, Sweden, Finland and Iceland have joined forces to tackle three important challenges for the transition to more sustainable materials:

- agreement on a common set of functional criteria for sustainable materials
- sufficient Environmental Product Declarations (EPD) for Nordic products to enable manufacturers to get credit from their development of sustainable products and
- simplification of the procurement, planning and construction process for sustainable materials

The project will also provide practical guidelines for building owners who require the use of sustainable building materials and will be applicable for all types of building and rehabilitation projects.

The Green Building Councils in Norway, Sweden, Finland and Iceland are all partners in the project. Each country's respective GBC consists of members from the whole value chain and these members are invited to join the project. The project consists of five work packages. Work package 1 is written by the Swedish Green Building Council, gives a short overview of regulations in this field and existing commonly used tools and criteria in each country. The state-of-the art-report summarizes the results and the report comprises important input for our Nordic efforts to identify common functional criteria for sustainable materials.

The Norwegian Green Building Council has been in charge of work package 2 and is responsible for this report. There has been close collaboration between all of the partners in obtaining information from all four countries.

The main purpose of work package 3 was to increase the awareness of Environmental Product Declaration (EPD) in the Nordic building market, and map knowledge and status of the use of EPD in the market. It has been run a web survey among both producers and users of EPDs in each country to identify obstacles and based on these results brochures to both producers and users of EPDs will be produced. The Icelandic Green Buling Council has written a report on the results from the survey and the brochure.

Work package 4 consists is the practical "Guide to sustainable materials". Norwegian Green Builing Council and Green Building Council Finland have collaborated in this work package. It has been written a full report discussing materials' sustainability and it is practical guidelines for design and procurement of sustainable building materials.

1.2. Need for common criteria

The sustainability of building materials is of great importance for the total ecological footprint of a building. More and more building projects demand for sustainable materials, but the manufacturers' experience that the requested criteria and types of documentation differ from country to country and from project to project. It is expensive for the manufacturers, who often deliver products across the borders, to analyze and prepare for different documentation (e.g. lab tests, environmental labels) to meet these changing demands. The challenge is therefore to harmonize the functional criteria and the accepted documentation across the Nordic countries.

Need for a system that credits sustainable product development:

The manufacturers also experience that some types of materials are rejected in projects with a sustainable approach due to lack of knowledge or because the tools are based on generic data from common ways of producing these materials in Europe (e.g. The Green Guide in BREEAM Europe). The Nordic producers have in general more focus on hazardous substances and rather good access to clean energy that makes their products more sustainable than the common way of producing these materials in the rest of the world (e.g gypsum, EPS, concrete and wooden products). There is a need to develop an evaluation system that is based on specific product information (as e.g. Environmental Product Declarations (EPD) and The Nordic Swan) that gives credit to the Nordic manufacturers and promotes their products both in the Nordic countries and in other countries as well.

Through close cooperation between the GBC's and the building product industry, one of the project's objectives is to harmonize criteria for sustainable products and define accepted ways to document these criteria. The criteria has to be clear, well specified, realistic and manageable and has to include the most important environmental influences from building materials.

The criteria will be helpful to use either in connection with different environmental assessment tools, or separately as basis for an informed selection of sustainable building materials. Four indicators are chosen to define sustainability of building materials: Global warming potential, Material resources, Hazardous substances and Emissions to indoor climate. The users, either through a tool or separate conditions in procurement, decide if one or several of these indicators should be used as basis for their selection of products, and if the products meet the given criteria for the chosen indicators and the selected sustainability ambition level of the user regarding each criteria.

How this can be done, will be described in the full report of this project (WP4), or the "Guidelines to procurement".

1.3. Working method

In all four participating countries there has been organized several national workshops to discuss possible indicators and criteria to be able to define sustainability for building materials in the Nordic level.

Experiences from these national workshops have been distributed to all the other participating countries to ensure that the discussions are harmonized across the borders and that all understand the different national obstacles and possibilities.

During the working period, there have been regular meetings between all National project managers to discuss and determine principles needed for further discussions and work on national basis.

Since Norway have had the project manager of work package 2, the first national workshops have been held in Norway, with subsequent workshops in the other countries to follow up the discussions and preliminary suggested conclusions that come up in the first Norwegian workshop.

The discussions in each country have, to some extent, also been connected to national development of relevant issues, for instance the new Norwegian BREEAM Nor version, the EPD-development in Finland and the revision of the Building Product Declaration (BPD) [1] in Sweden.

In the national workshops the representatives from around more or less the whole value chain (R&D, certification, material producers, contractors, architects and consultants, private and public building

[1] www.byggvarudeklarationer.se

owners, the Building Authority and the Environment Agency) have taken part to the discussion. Totally more than 100 people have been involved in these workshops with lively discussions about indicators regarding sustainable building materials.

Some of the outcome of this project is increased knowledge for the workshop participant due to all discussions on national and Nordic levels in addition to the reported indicators. It has been necessary to use much time to discuss and let the discussion mature until the project could agree on common indicators. The need of discussions depended among other things on the experiences of sustainability of materials and how the various existing national documentation system could be included in the indicators.

2. Results/Criteria

2.1. Four sustainability indicators

Summary: Four indicators describe the sustainability of building materials. These indicators are Global warming potential – greenhouse gases, Material resources, Hazardous substances and Emissions to indoor climate

The four participating countries have agreed upon four sustainability indicators to be used to the define sustainability of building materials and products.

Other indicators have also been discussed in the process defining practical indicators, either as separate indicators or as an indicator as a replacement of one of the four mentioned above. An example of this is energy use as an indicator instead or in addition to global warming potential (GWP). Since GWP is based both on energy use and type of energy, both important factors to reduce greenhouse gases, we choose not to prioritize between these indicators but leave it to the producers to choose the most efficient measures to reduce the greenhouse gases in the production of new products.

An important principle has been that all indicators could be found from existing documentation systems, either from one single system or from several systems that document only one or some of the indicators.

The four indicators are

- Global warming potential – greenhouse gases (GWP)
- Material resources
- Hazardous substances
- Emissions to indoor climate

Verified EPDs are the most central documentation since they are based on international standardization. All four indicators can more or less all be found in at least Norwegian EPDs but also to some extent in EPDs from other national programme operators. All EPDs include information

about the two first indicators, while Hazardous substances and Emissions to indoor climate are included in some EPDs.

If such information is lacking, it must be found through other documentation, such as safety data sheets, self-declaration from the producer or certification labeling systems.

The indicators are based on knowledge of today, and revisions will be necessary when new knowledge of testing methods and documentation is developed.

As a basis, all product groups should document all four indicators, but this is modified to some extent. Products used in small quantities in buildings contribute with small impacts of for instance green house gases. For other products that is not used indoor it is of now argument to request for indoor air emission documentation or certification.

2.2. Three levels for each indicator

Summary: The four indicators are split into three sustainable ambition levels. These three levels are called Best Nordic practice, High ambitions and Good ambitious.

In the beginning of the project, most participants expected to end up with only one level for each indicator representing the most sustainable level for building products. As we got to know each other's varied experiences and different systems across the borders, we realized that each indicator needed several levels to be able to take differences into account.

Norway has experience from all four indicators from existing environmental assessment systems and building projects where one or several of the indicators are part of the procurement. EPDs for building materials are well established and are quite often required in building projects. The Norwegian EDP-database (EPD-Norway)[2] has in the autumn 2015 around 250 EPDs for building products from more than 90 different companies. Most producers are Norwegian but in the last years the interest on EPDs on the behalf of international producers have increased.

The well-established declaration systems, Building Material Assessment (BVD)[3], Sunda hus[4] and BASTA[5] when it comes to documentation of building products that exceed declaration of performance according to international laws. These systems focus mostly at harmful substances. Building Material Assessment and BASTA have harmonized criteria and the declaration system is revised in 2015. There are some EPDs for building materials in the Swedish system, operated by Environdec[6].

The Nordic Ecolabel ("the Swan") is a well-established official and voluntary environmental labelling system[7]. The Nordic Ecolabel sets specific requirements within relevant sustainability indicators through the products life cycle, including the four mentioned in this project. The requirements are

[2] www.epd-norge.no
[3] www.byggvarubedomningen.se
[4] www.sundahus.se
[5] www.bastaonline.se
[6] www.environdec.com
[7] http://www.nordic-ecolabel.org/

set for a wide range of building products. As an example hazardous substances are regulated not only in the final product, but also as when used during the production. About 1600 Swan labelled building products from 50 different license holders are on the Nordic marked (January 2016). There are also building products labelled with the EU Ecolabel on the Nordic marked, where indoor and outdoor paints and varnishes are the most common.

The Finnish Emission Classification of Building Materials (M1) from The Building Information Foundation RTS is well established, and the most common labeling system used for both manufacturers, importers and exporters of building products in the Nordic countries. The Finnish building product association plans to reestablish a programme for EPD for building materials, and started the process early 2015.

Iceland has only few producers of building materials and imports materials and products from more than 100 countries. The challenge is to require products with sustainable qualities without criteria describing the conditions.

Due to the large variation of experiences in the Nordic countries, will both the need for more documentation and given sustainable levels contribute to further development of sustainable building materials in all countries.

Consequently, both type of documentation and achieved quality are used as basis to split all indicators into three levels describing the ambitions of the sustainability of building materials.

Table 2.1 Three levels describing the sustainable ambitions for building materials

	Ambition level	**Documentation**
Product nn	Best Nordic practice	Given level based on standardized verified declaration
	High ambitions	Verified declaration
	Good ambitions	Self-declaration

The most ambitious level for each of the four indicators will be the best practice in one or several of the four Nordic countries. This means that the most ambitious level for one indicator can be best practice in one country, while the most ambitious level for another indicator can be decided based on best practice from another country.

Greenhouse gas emissions and Material resources follow this main principle more or less like described above, while Harmful substances deviates a little, especially according to the experiences from Sweden, where it is possible to be more specific about the quality levels. For Emissions to indoor climate, there are also standardized test methods and levels that can be used to define the levels.

Table 2.2 Principles used describing the sustainable ambitions for building materials

	Greenhouse gas emissions	**Material resources**	**Hazardous substances**	**Emissions to indoor climate**
Product nn	Given level based on verified (LCA) declaration	Given level based on verified (LCA) declaration or Certification	Given level based on verified declaration	Given level based on verified declaration or Certification

	Verified declaration	Verified declaration	Given level based on verified declaration	Given level based on verified declaration
	Self-declaration	Self-declaration	Self-declaration	Self-Declaration

The level called "Good ambitions" is represented by asking for self-declaration for all indicators since it is important to at least declare the performance even if it is not based on either existing standards or third part verifications. Examples of such self-declarations are the Swedish Building Material declaration (BPD) or laboratory tests by the producers themselves.

The level called "High ambitions" is represented by asking for declaration based on international standards and verified by a third part. Examples of this are for instance EPD based on ISO 14025 and EN 15804, Ecolabel based on ISO 14024, Building Material Assessment and SINTEF Technical approval.

The level called "Best Nordic practice" is represented by setting criteria for what the products have to fulfill.

Chapter 3 describes which documentations system that fulfils the various levels and criteria.

Table 2.3 Example 1 describing the criteria for a building material

	Greenhouse gas emissions	**Material resources**	**Hazardous substances**	**Emissions to indoor climate**
Building boards 12,5 mm	3,0 kg CO_2 ekv/m^2	More than 30 % recycled materials	Substances less than limits in Table 2.11, Best Nordic practice or Ecolabel, BVB recommended, Sunda hus level A, Green Ecoproduct level 1 [8]	Low emission level (according to EN 15251, for instance M1)
	EPD	EPD	Substances less than limits in Table 2.11, High ambitions or BASTA, BVB accepted, Sunda hus level B, SINTEF Technical approval, Green Ecoproduct level 3 [7]	Medium emission level (for instance M2)
	Building Material Declaration etc	Building Material Declaration etc	Building Material Declaration etc and less than 0,1 % substances on the Reach candidate lists	-

[8] From April 2016

Table 2.4 Example 2 describing the criteria for a building material

	Greenhouse gas emissions	Material resources	Hazardous substances	Emissions to indoor climate
Concrete (B30)	200 kg CO_2 ekv/m^3	More than 5 % recycled materials	Substances less than limits in Table 2.11, Best Nordic practice or BVB recommended, Green Ecoproduct level 1, Sunda hus level A	Not relevant
	EPD	EPD	Substances less than limits in Table 2.11, High ambitions or BASTA, BVB accepted, Sunda hus level B, SINTEF Technical approval, Green Ecoproduct level 3 [7]	Not relevant
	Building Material Declaration etc	Building Material Declaration etc	Building Material Declaration etc and less than 0,1 % substances on the Reach candidate lists	-

2.3. How to group the materials?

Summary: The criteria for the indicators Greenhouse gas emissions and Resources is established depending of type of material. The materials are therefore grouped dependent of major functions.

The emissions of greenhouse gases from the production vary from one product group to another which means that we need reference values for each product groups to establish the levels that define the Best Nordic level for the greenhouse gas indicator.

The same situation is to some extent present for the Material resources-indicator since the possibility to increase the material efficiency differs between the product groups.

Independent of how the materials are grouped, the grouping will not be correct for all kind of functions that the product fulfils. Insulation and building boards must for instance both fulfil one or more of the functions regarding thermal conductivity, fire resistance, density, acoustics and so on. Grouping of materials might therefore be difficult, but is still done even of all these differences, both in this project but also when we talk about products in general. We define products in groups like insulation, building boards, slabs, columns, windows, flooring products and so on.

When designing buildings most of these product groups have to be defined much more detailed when the products are given needed functions. Examples of these is when insulation is split into unflammable and flammable insulation, density groups etc, building boards are split into gypsum, chipboards etc while beams are split into concrete, steel and wooden beams.

Another aspect that have been discussed regarding grouping of products with the sustainability aspect is if the various PCRs should be taking into account since the EPDs for comparable products might be based on different PCRs. This means that the PCR is the basis of the group, and all products included in the PCR constitute a product group. The major problem with such approach is that comparable products with EPDs from two different EPD-operators will not be in the same group even if they are more or less the same product. The conclusion of such discussion is that products might me compared independent of which PCR that is used, but still *a comparison have to be done with caution*, especially if scenarios are included in the comparison basis. When using this indicator in procurement documents, it have to be considered carefully if the indicator level represents products that fulfill all the needed functional requirements.

Since the Best Nordic practice-level for the greenhouse gas and the Resources indicators are based on EPDs, it is a need of enough data to establish such reference levels.

Possible product groups discussed are:

- Concrete
- Concrete elements
- Steel constructions
- Insulation
- Building boards
- Windows and doors
- Flooring products
- Roofing products
- Wooden products

For some product groups it is necessary to split into more detailed material groups since functions are obtained by using various sub products. One example is for instance windows made of either wood, plastic or metals were some of the indicators might vary dependent of type of materials used in the product.

2.4. The whole lifecycle or only part of the lifecycle?

Summary: Only the production phase (A1-A3) is included in the criteria for Greenhouse gas emissions. In addition is transport (A4) and the user phase represented by maintenance recommended evaluated in each project.

An EPD is based on a life cycle assessment according to ISO 14040-14044. As a minimum, all EPDs should include the stages A1 – A3, while it differs how many of the other phases and stages are included in addition to the Production stage.

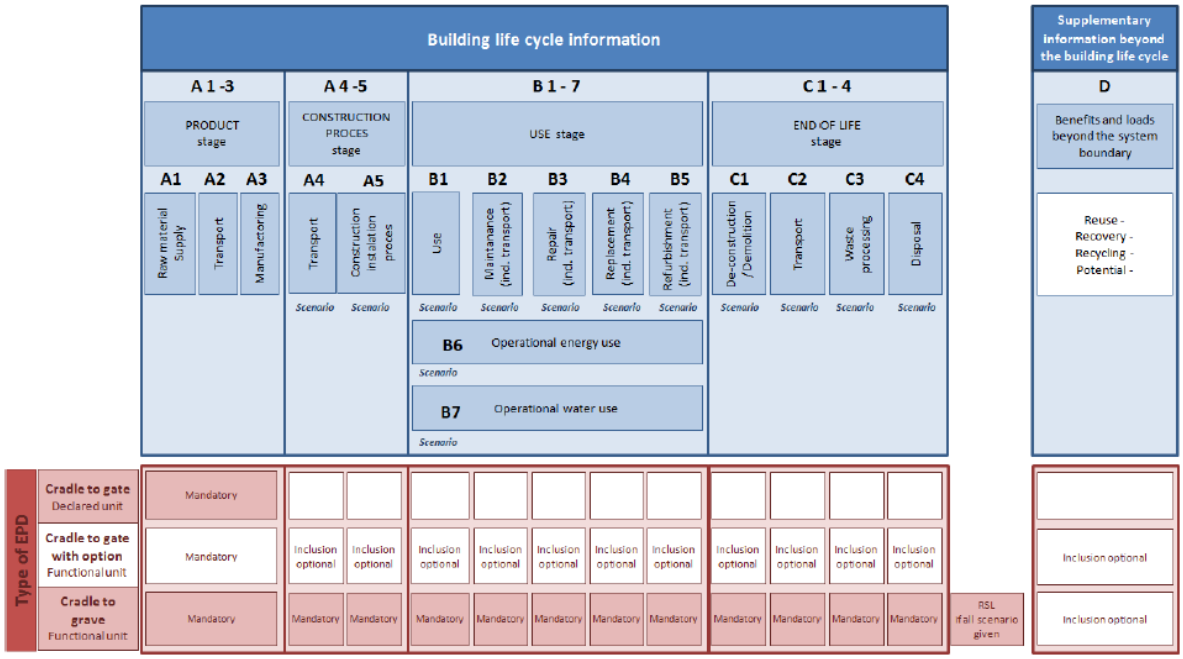


Figure 2.1 Types of EPD with respect to life cycle stages and modules covered for the building assessment

For all Norwegian EPDs it is more or less mandatory to at least also include A4, Transport to the construction site. This is also the case with several other EPD operators. If possible and preferable, the EPDs should also include the rest of the lifecycle, based on scenarios described in the respective PCR's.

The Finnish Building Information Foundation is during 2015 preparing work for the future Finnish EDPs. The very first draft of rules on how to compile Finnish EPD is now under works and so far it is planned that A1-3 and module D will be compulsory. If this will be the final result is still unknown, but yet it seems that environmental impact from transport is not as highlighted as in Norway.

The emissions caused by transport depend of distance and type of transport; transport to the construction site may contribute with a large share of greenhouse gas emissions for building materials. How to estimate indicators regarding transport may however be difficult since the need of transport varies significant between the Nordic countries. The three countries Finland, Sweden and Norway have long transport distances and few producers, which means that transport of building materials may be significant to some building sites. Transport may be by boat, railway or truck, where the truck probably is the most commonly used to reduce the time of transport. Building materials are both produced domestically or are imported from other countries - both from the other Nordic countries and from the rest of Europe or the rest of the world.

The majority of the building material used in Iceland is imported and have to be transported by sea, and land. Locally produced material is transported either by sea or with trucks.

Examples from EPDs for producers of hollow core slabs show that the share of transport to the construction site varies from around 1 % of the emissions from A1-A3 to more than 40 % for another producer. The first example is transport from a local producer while the last example is from a producer importing slabs.

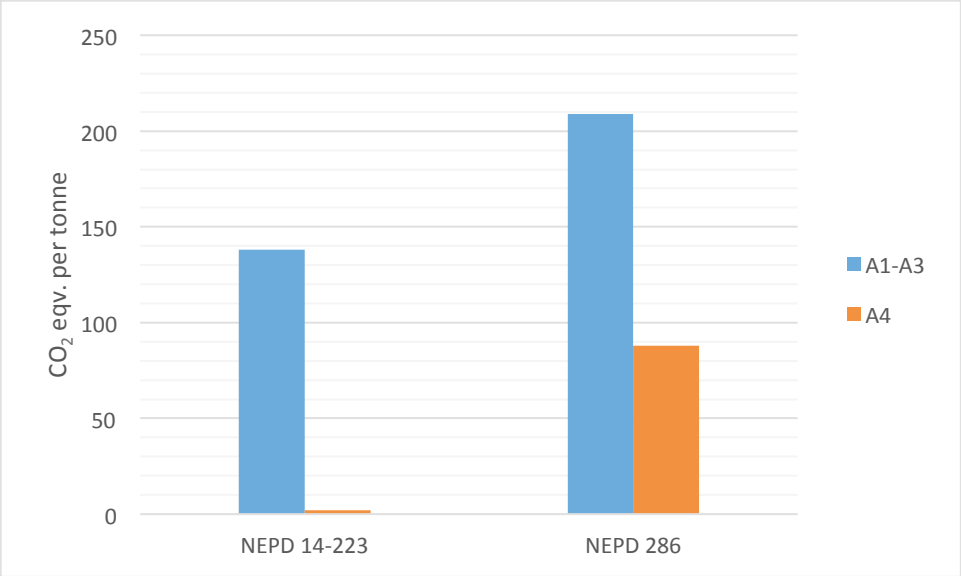


Figure 2.2 Example of CO_2 emissions from the production stage (A1-A3) and transport (A4) for two producers of hollow core slabs.

Even if transport of building materials might have significant contribution of the environmental impact, it will be more or less impossible to indicate an acceptable impact level for the Nordic. In each building project and it should however be included for given materials as a part of the procurement requirements.

The same situation is regarding the use-stage of products (B1-B5) and End of life stage (C1-C4) that must be based on chosen scenarios.

This Nordic project chooses not to base the criteria on scenarios since these will vary significant from one country to another, even within the Nordic countries. The reference values should aim to represent all Nordic countries, which mean that the references should be based on values from the production stages that are representative for all countries and products.

Emissions caused by transport, the user stage and end of life should be taken care of on a national level.

2.4. How to decide the most ambitious levels?

In this subchapter it is discussed how the levels "Best Nordic practice" are decided for each of the four indicators.

2.4.1. Greenhouse gas emissions

Summary: The most ambitious levels for each product group are more or less based on the established Norwegian method Ecoproduct. The indicator is described as greenhouse gas emissions lower than given limits specified for some product groups.

The most ambitious levels are the most challenging to decide, especially on greenhouse gas emissions where the experiences on levels are fairly low in all countries except Norway. Several

Norwegian building projects sets today criteria for maximum acceptable greenhouse gas emissions from products. The ambitious level must be given at a level that is either not too high or low.

The Norwegian Ecoproduct [9] and Klimagassregnskap.no[10], which are both databases on greenhouse gas emissions, can be used as basis for a Nordic level. Both Ecoproduct and Klimagassregnskap.no are described in Annex 3 in the report from workpackage 1 in the Nordic guide-project "Nordic guide to sustainable materials. WP1-State of the Art". In addition to these databases, a report (Grønn materialguide) assigned by the Norwegian directory of Buildings (DiBK) and Green Building Alliance (GBA), presents the range of values for some chosen indicators for 6 product groups[11].

Another reference, as for instance industry-norms, is perhaps the most useful references, like the classification of concrete depended on the characteristic strength defined by the Norwegian Concrete Association. In Table 2.5 is maximum CO_2-emissions given for three ambition levels together with an established reference.

Table 2.5 Norwegian classification of concrete based on greenhouse gas emissions [12]

Strength Durability	C20 M90	C25 M90	C30 M60	C35 M(F)45	C35 M(F)40	B45 M(F)40	B55 M(F)40
	Maximum greenhouse gas emissions (kg CO_2-ekv. pr. m^3 concrete)						
Low carbon A	170	180	200	210	230	240	250
Low carbon A	200	220	240	270	300	310	320
Low carbon A	240	260	280	320	350	360	270
Reference	280	300	320	370	410	420	430

In Ecoproduct is the assessment (Green, White or Red) of Greenhouse gas emissions made in relation to a reference value for comparable products. If the greenhouse gas emissions are 70 % or lower than the reference value, the product gets a green Ecoproduct level for this indicator. The 70 % is the case for all product types in the method. The method is revised July 2015 and the basis with 70 % of a reference values is still kept for the most ambitions green level. The 70 % level indicates that these products have significant lower greenhouse gas emissions than the average for comparable products, about correspondingly like Ecolabelled products that should be of the about 30 % "best" products.

Table 2.6 Criteria for determining the parameter Greenhouse gas emissions in Ecoproduct

[9] http://www.byggeportalen.no/Byggeportalen/ (In Norwegian)
[10] http://www.klimagassregnskap.no/ (In Norwegian)
[11] http://byggalliansen.no/nyside/veiledere/ (Grønn materialguide – in Norwegian)
[12] Publication 37. Lavkarbonbetong (Low carbon concrete). The Norwegians concrete association. June 2015 (In Norwegian)

Criteria (% of reference value)	Assessment	Grade
x ≤ 10 %	Excellent	1
10 % < x ≤ 40 %	Good	2
40 % < x ≤ 70 %	Average to good	3
70 % < x ≤ 100 %	Average	4
100 % < x ≤ 130 %	Borderline fair	5
130 % < x ≤ 160 %	Marginally acceptable	6
160 % < x < 190 %	Poor	7
x ≥ 190 %	Unacceptable	8

The reference level in Ecoproduct is more or less be based on the same references values used in the Norwegian tool Klimagassregnskap.no. The values in Klimagassregnskap.no are more or less based on European reference Life Cycle Database and some Norwegian and international EPDs for few product groups. The reference levels both in Ecoproduct and Klimagassregnskap.no might be adjusted by 1th of January each year if several new products lead to significant changes, based on the average of EPD values within the relevant product group.

The reference value will be based on comparable products. An important question to ask is "When are products comparable?" According to the standard EN15804:2012+A1:2013 *comparisons between construction products can be carried out in the context of their application in the building"*. This means that products can be compared when (all) the same functional requirements are met, and the influence of the whole construction and the building are taken into account. Comparison of a product against the requirement must therefore be done with caution since the product might have different properties except the property used for when the reference value is decided.

To elaborate on how to compare products with some reference values, some products are used as examples. All examples are based on Greenhouse gas emissions for the production modules in EPDs, that is A1-A3.

Concrete

The first example is concrete and 12 products produced in either Norway, Germany or New Zealand where all have EPDs. The EPDs are found in databases from either the Norwegian, German and Swedish EPD-operator. Figure 2.3 shows the EPD-values compared with the reference values and "Best practice – Lowcarbon A" in Table 2.5.

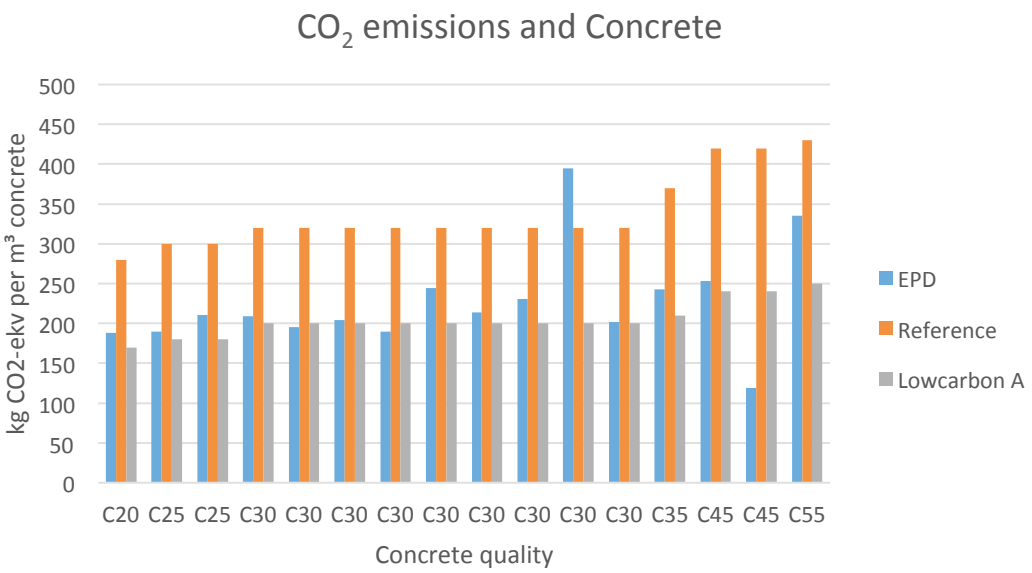


Figure 2.3 CO_2-emissions for concrete with different quality compared with Norwegian reference values

All concrete qualities in this figure unless one have lower CO_2-emissions than the reference, while all except one have higher emissions than the Lowcarbon level A. This is probably also a correct situation since most producers do still not produce lowcarbon concrete.

Precast concrete products

Another example is precast concrete products that are more problematic since there is a large number of different products that are based on different concrete quality and reinforcement.

Since more or less all EPDs for construction products are based on PCR for specific material groups it is a challenge to compare one construction product with one material to another construction with another material. Based on this we choose to split the groups into material based groups.

Precast concrete products is one such group, but also within the material group, there are several subgroups like slabs, walls, columns and beams with corresponding capacity and other functions. Since the LCA-results for most EPDs are related to tonn as functional unit, and that it is not established any agreed sizes and functions for the various products that could be used to compare products within, all precast concrete products could be gathered into the same group. Such procedure is not in accordance with EN 15804.

The average of 21 existing EPD for precast concrete slabs, both hollow core and massive slabs, column, beams and wall is 167 kg CO_2-eqv per tonn. The average for the 10 hollow core slabs with varying dimensions is 150 kg CO_2-eqv/tonn, for the 3 columns 185 CO_2-eqv/tonn and for the 5 beams it's 205 CO_2-eqv/tonn.

The dimensions for the hollow core slabs also vary a little, from 200 to 400 mm height, but it seems that the dimensions have fairly low, if any, significance on the emissions per tonn element. Type of concrete, the amount and type of reinforcement and if this reinforcement is based on recycled steel have probably higher influence. For two of the products the dimensions are not informed in the EPDs and represents all typical dimensions of hollow core slabs. In the figure below greenhouse gas emissions for these 11 hollow core slabs are shown and the variation is from about 125 to 209 kg CO_2-eqv per tonn, where both the lowest and highest emissions are represented by producers and

EPDs for all dimensions. The average for these 11 elements, independent of dimensions is 149 kg CO_2-eqv per tonn. When also other concrete slabs within the database of EPD-Norway from November 2015 is included the average is 153 kg CO_2-eqv per tonn.

Figure 2.4 Comparison of GWP between 11 different hollow core slabs with different dimensions.

If 25 precast concrete products with EPDs in the database of EPD-Norway are compared with the average for all product independent of type of product and capacity, will none of the 25 products meet the highest level of 70 % of the reference values (which is the average of the same products). This is also expected since no of these products are based on low carbon concrete, and probably not with recycled steel as reinforcement.

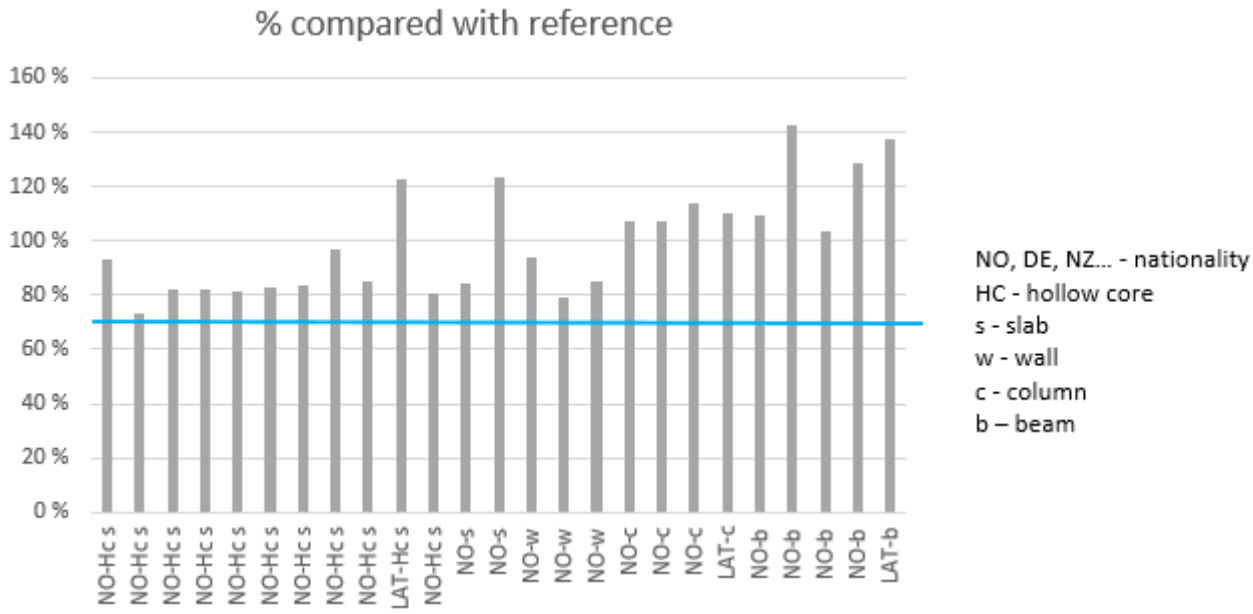


Figure 2.5 Comparison of GWP between 25 precast concrete products.

Reinforcement

The GWP for the production of reinforcement depends strongly on the amount of scrap used in the production, and the differences are fairly high. In Figure 2.6 the product with the highest GWP contains of no scrap steel, while the others contain of more than 95 % scrap.

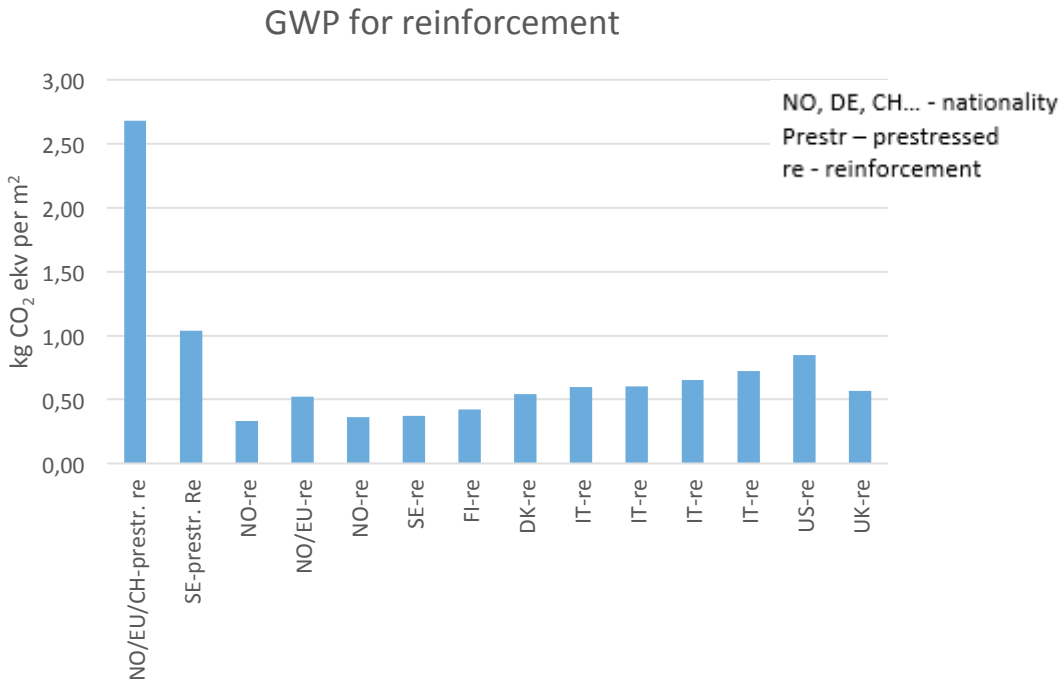


Figure 2.6 Comparison of GWP between 14 reinforcement products.

Building boards

Another example is building boards and the GWP based on 23 different products, mostly gypsum boards, but also some particleboards. In such comparison, it is important to be aware that the values for greenhouse gas emissions for product groups based on wooden products may include sequestration of carbon dioxide of biogenic origin. Such sequestration must be corrected when comparison with other products that is not wooden based.

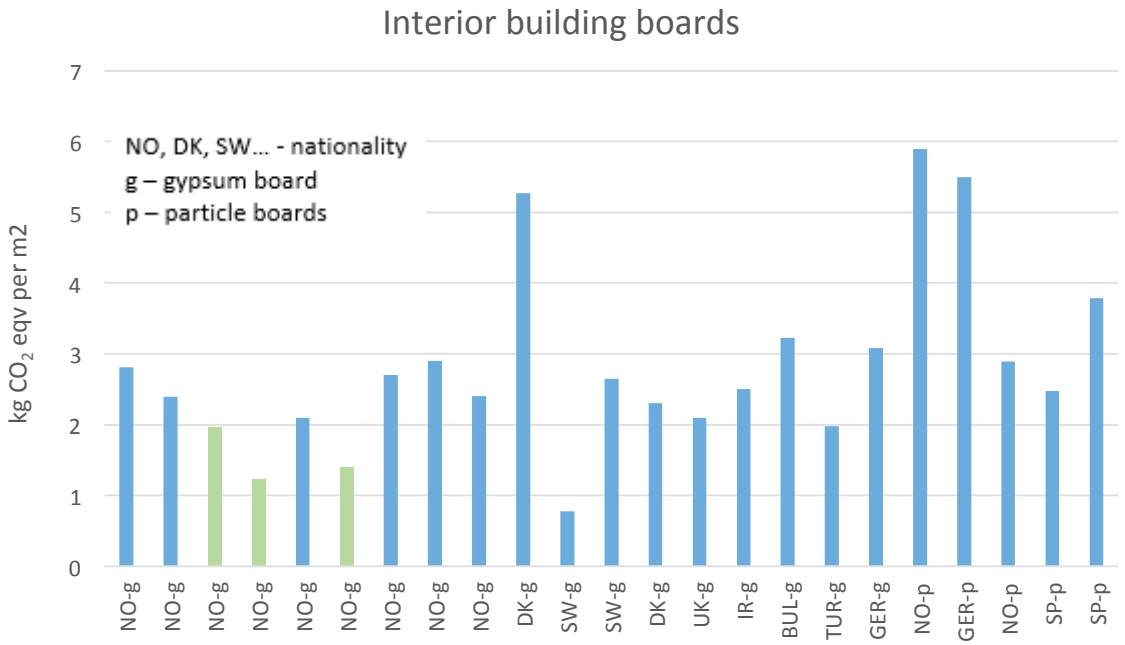


Figure 2.7 Comparison of GWP between 23 building boards. The green columns represents products thinner than 12,5 mm, the blue columns are 12,5 mm boards. The red line is the average for the 12,5 mm boards, 3 kg CO_2 eqv per m^2.

Alternatively, the environmental impact can be presented as impact per kg building boards instead of m^2. In such cases, even different product with different dimensions may be compared.

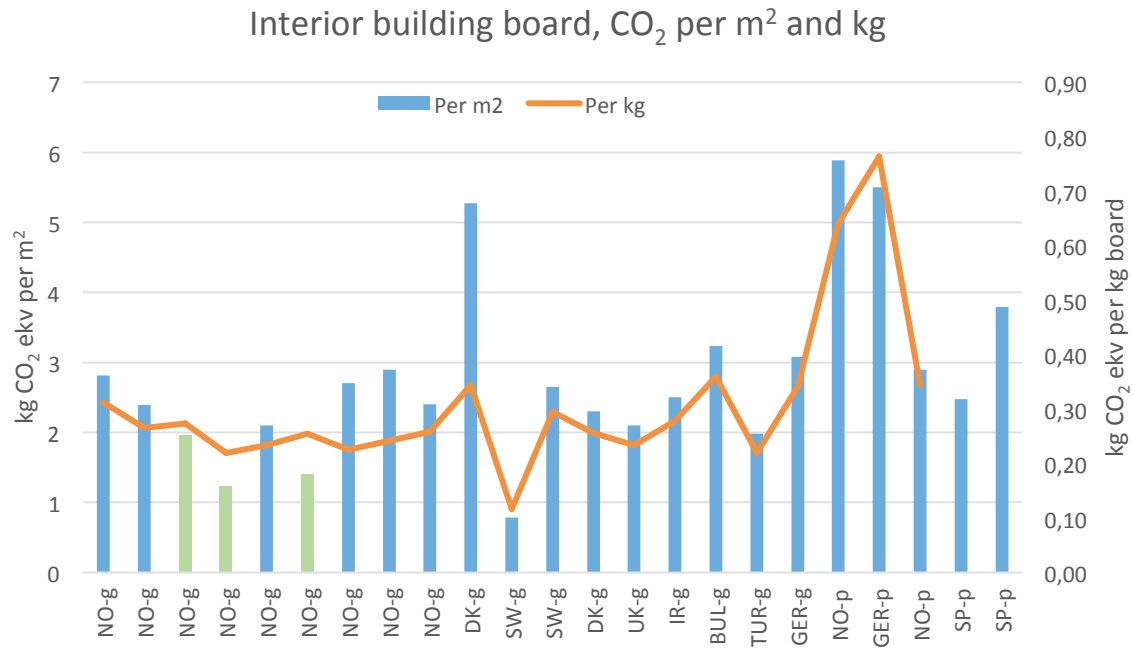


Figure 2.8 Comparison of GWP between 23 building boards. The green columns represents products thinner than 12,5 mm, the blue columns are 12,5 mm boards. The red line is the GWP independent on thickness, 0,31 kg CO_2 eqv per kg board.

Windows

The next example is GWP for windows, which introduce an interesting issue, the lifetime of a product. In the figure below is the GWP for 18 windows presented, both wooden, steel and PVC-windows. The 7 first windows are wooden windows without aluminum cladding with an indicated lifetime of 40 years. The rest is either with aluminum cladding or other materials with an indicated lifetime of 50-60 years. If we choose not to take expected service life into consideration when defining the reference values, the average for these 18 windows are about 140 kg CO_2-eqv per window (Fig. 2.6). The windows without the aluminum cladding seems to be the most sustainable windows in a A1-A3-perspective.

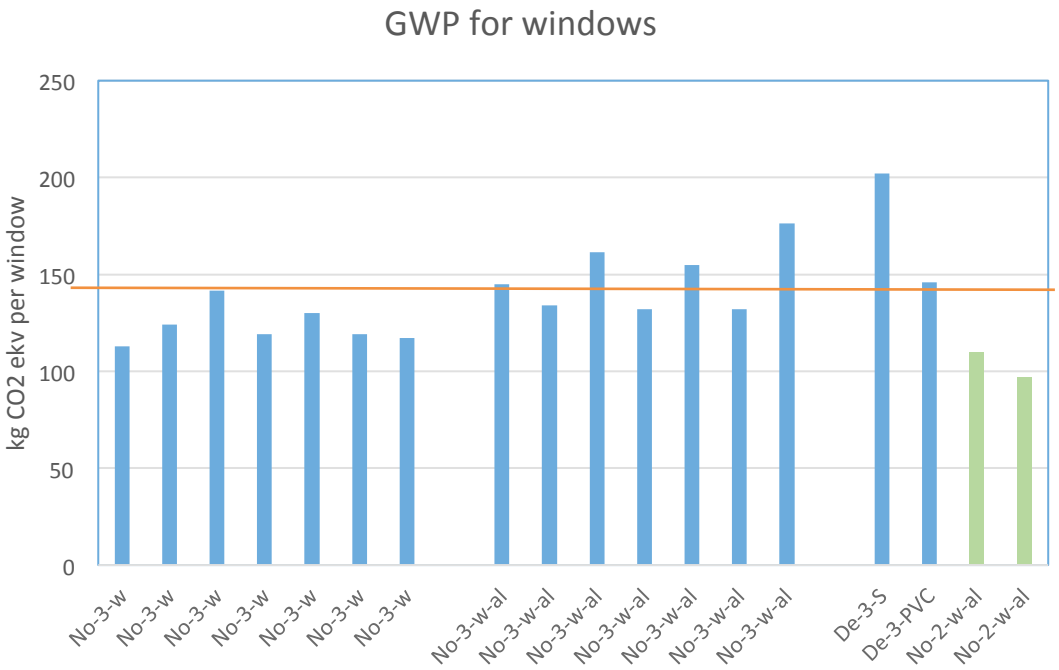


Figure 2.9 Comparison of GWP between 18 windows independent of expected service life. The green columns represents windows with two layers of glass. The red line is the average for the 3 glassed windows, 139 kg CO_2 eqv per window.

If we take the lifetime into consideration, we need to adjust the GWP to an expected lifetime of the building. According to the declared values in the EPD, many windows without aluminum cladding have higher Greenhouse gas emissions than the windows with aluminum cladding since the windows without aluminum probably have to be changed once in the lifetime of the building.

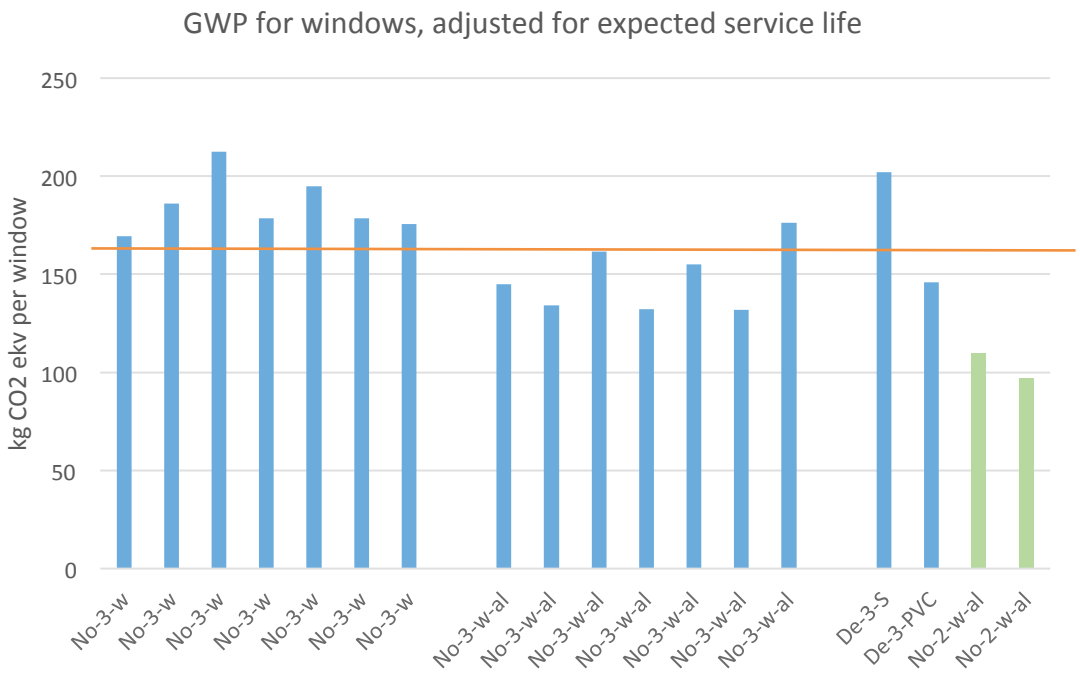


Figure 2.10 Comparison of GWP between 18 windows when expected service life is included. The green columns represents windows with two layers of glass. The red line is the average for the 3 glassed windows adjusted for expected service life, 164 kg CO_2 eqv per window.

Instead of using window with standardized sizes (were most EPDs for windows are based on), the GWP might be presented as impacts per kg product. The average for the same 3 glassed windows as presented in Figure 2.9 is 2,52 kg CO_2 eqv per kg window.

Insulation

The last product group is insulation consisting of both mineralwool of either glass or stone, XPS, EPS and PU. Many different types of insulation were one of the functions for all insulation types is insulating against temperature. In addition, dependent on type of insulation and intended use, the insulation should also cover other functions as for instance sound insulation and fire resistance. The strength, as a function of density will also vary between some insulation types. A comparison between insulation types or against GWP-requirements must therefore be done by caution to ensure that the insulation cover all the needed functions.

The declared unit of insulation is either 1 m^2 and R=1, m^3 or in some seldom cases in kg. In the figure below is the GWP presented both by m^2 and R=1. As we see, the variations as fairly large but some of the variations are due to variation in density of the products.

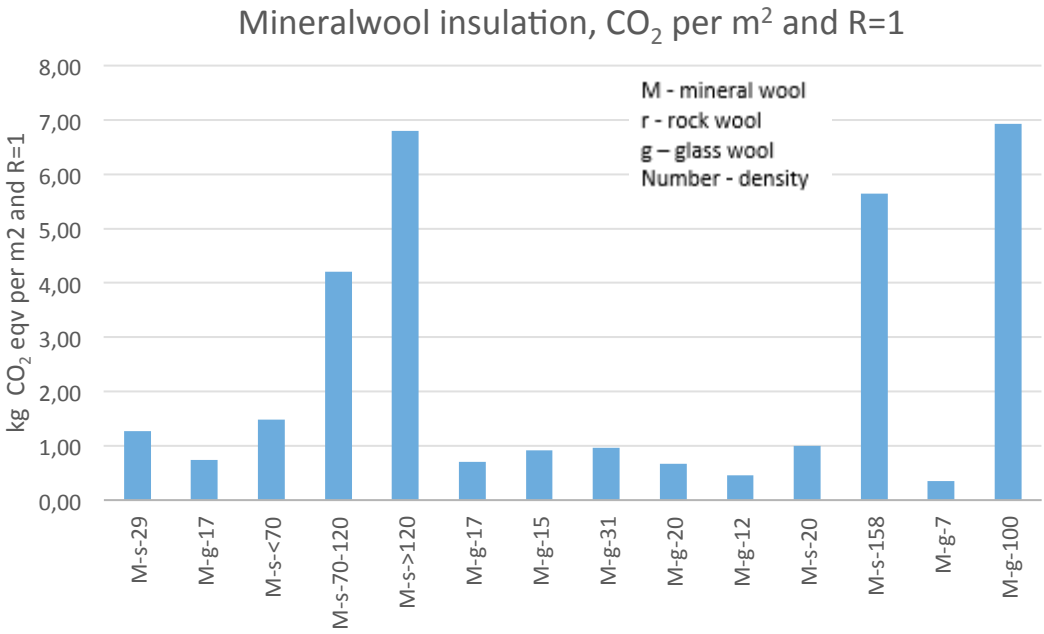


Figure 2.11 Comparison of GWP between 14 different types of mineralwool insulation.

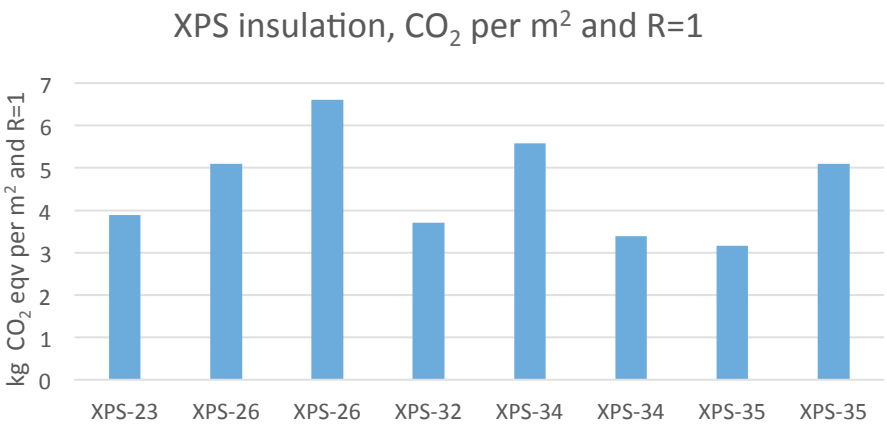


Figure 2.12 Comparison of GWP between 14 different types of XPS insulation. The number in the horizontal axis indicates the density of the insulation

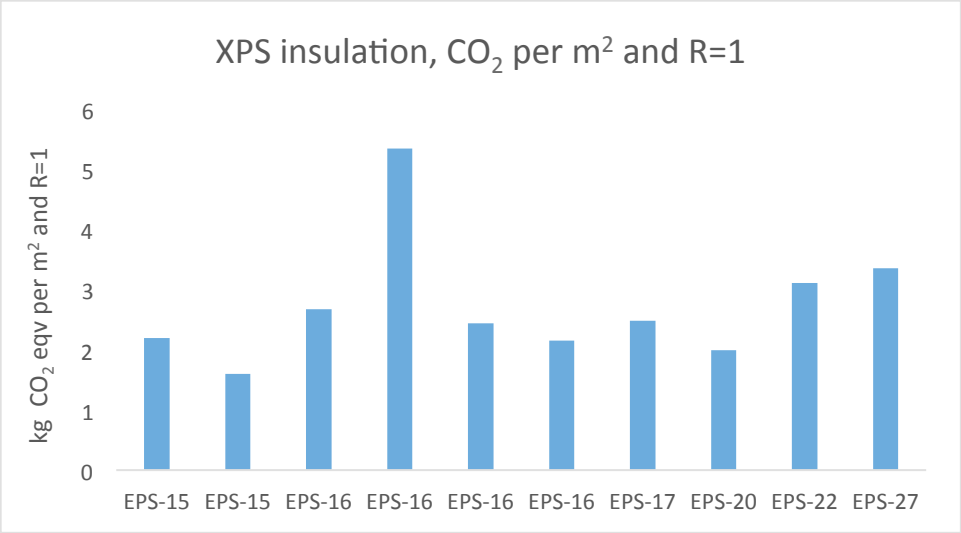


Figure 2.13 Comparison of GWP between 14 different types of EPS insulation. The number in the horizontal axis indicates the density of the insulation

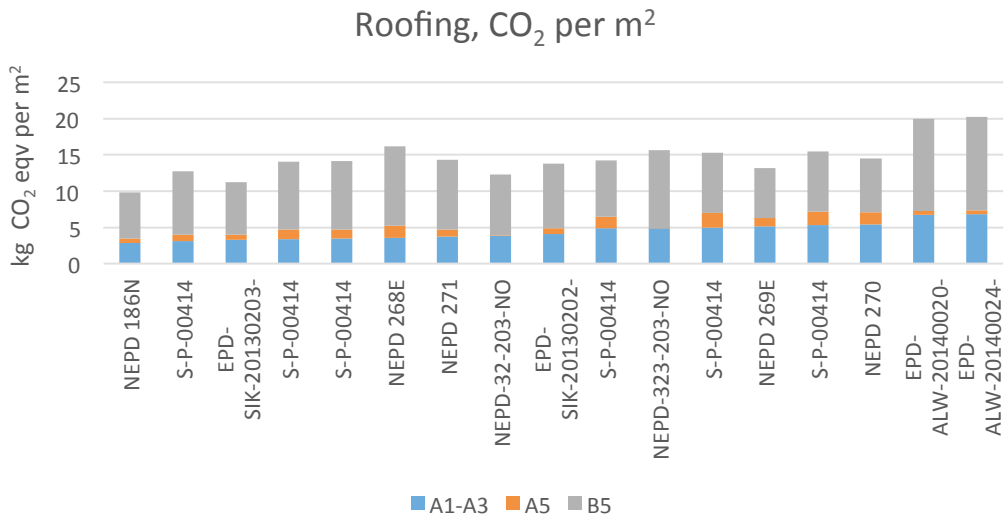


Figure 2.14 Comparison of GWP between 17 different types of butiumen and polumer roofing products. The CO_2-emissions is both for the production (A1-A3), the installation (A5) and refurbishment (B5) phases.

Floor coverings

Floor covering consists of quite many different types of coverings, depending of type of buildings, localization in the building and the loads of use. The lifetime and maintenance have in many cases also large influence in the total environmental load. It might therefore be difficult to indicate a simplified level of greenhouse gas emission even if the variation of emissions is significant within typical groups of floor coverings as illustrated in Figure 2.15.

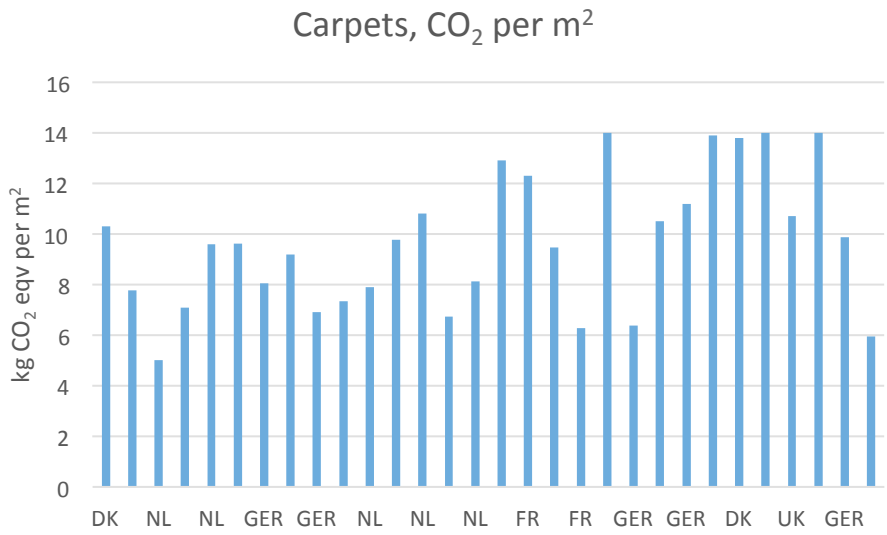


Figure 2.15 Comparison of GWP between 30 different types of carpets.

The reference values

As these examples show, it is difficult and time consuming to establish accountable reference values for a number of product groups. To be able to find the correct reference values and to update the reference due to development of productions methods and products, the Ecoproduct system with its reference values and operator will ensure high quality both when the indicators are established and the maintenance of the reference values. The exception is for concrete were it is established limits describing the most ambitious level, low carbon A concrete.

The revised reference values based on EN 15804 will be finished during the winter 2016.

Table 2.7 Reference values for Greenhouse Gas Emissions (GWP) – preliminary values until new values from Ecoproduct is produced.

	Reference values	**Reference**
Concrete		
C20/M90	170 kg CO_2-ekv pr m^3	Low carbon class A (the Norwegian Concrete Association)
C25/M90	180 kg CO_2-ekv pr m^3	
C30/M60	200 kg CO_2-ekv pr m^3	
C35/M45	220 kg CO_2-ekv pr m^3	
C45/M40	240 kg CO_2-ekv pr m^3	
C55/M40	250 kg CO_2-ekv pr m^3	
Reinforcement	0,6 kg CO_2-ekv pr kg	EPDs
Building boards	3,0 kg CO_2-ekv pr m^2, alt. 0,30 CO_2-ekv pr kg	
Mineralwool (density < approx 30 kg/m^3)	1,5 kg CO_2-ekv pr m^2 and R=1	
EPS	2,5 kg CO_2-ekv pr m^2 and R=1	
XPS	5,0 kg CO_2-ekv pr m^2 and R=1	
Windows adjusted for service life	160 kg CO_2-ekv pr window, alt. 2,5 CO_2-ekv pr kg	
Roofing products	5,0 kg CO_2-ekv pr m^2	

When these reference values are set, it will be possible for producers, contractors and developers to compare products based to these reference values.

Since Ecoprofile is an established method used in Norway, and the green level in this method is one of the criteria used in BREEAM Nor, the Nordic guide establishes the same level as best practice for the greenhouse gas emission indicator. Products with emissions lower than 70 % of the reference values are defined as "sustainable" regarding this indicator.

What about product groups with few or no EPDs?

Both Ecoproduct and Klimagassregnskap.no only deal with building materials and not with products as technical installations. Declaration such as EPDs is rare, at least at a Nordic level, and there are no clear reference values for such products. For other product groups it is difficult to establish a certain level for only the production phase since the most important impacts may come from maintenance or transport from the factory to the building site.

For technical installations and other product groups where we only have very few, if any EPDs, we choose to not define the most ambitious level for greenhouse gases. Such products will only have two levels, "Verified documentation" and "Self-declaration". For such products "Verified documentation" is also the requirement for "The Best Nordic practice" too stimulate environmental documentation for such products.

Table 2.8 The three levels of the indicator Greenhouse gas emissions

Best Nordic practice	Less than the reference level, A1-A3
High ambitions	Verified declaration
Good ambitions	Self-declaration

2.4.2 Material resources

Summary: Material resources are based on used secondary materials in the production of new materials. The levels are based on experiences from projects and EPDs. For wooden based products the level criteria is that the wood comes from certified forests and does not include any tropical wood.

What kind of indicator that could describe the use of material resources on a material level have been discussed widely. As a basis of this indicator, the input must be able to find in EPDs.

All EPDs according to EN 15804 include information about type and amount of energy and material resources used to produce the material and how much secondary materials and water that have been used. Some few EPDs also include a module D, which is outside the boundary systems in EPDs, that inform about the reuse/recycling-potential of the product based on scenarios for given markets.

In the Norwegian Ecoproduct-method that interpret EPD-results and present the result simplified, the indicator Resources is split into Material resources and Energy parameters and both are weighted the same. The Material resources are split into three other sub-parameters "Use of renewable and non-renewable materials, Use of secondary materials and Use of water. All have the same weighting.

As a simplification from Ecoproduct, an alternative might be to only use the most "critical and relevant" parameter regarding material resources and not all sub-parameters as in Ecoproduct and EPDs.

What is the most critical and relevant parameter, and is it possible to limit this indicator to only one parameter? This might differ from one material to another, and must be defined specified for each materials, as the reference level is defined for greenhouse gas emissions.

The most critical and relevant parameters that are not included in the other indicators, are at least the type of materials and if these are renewable or not. The use of renewable materials depends more or less, on what types of materials are evaluated, and might be difficult to have as a general parameter. It is for instance impossible to produce concrete slabs based on for instance more than 60 % renewable materials, while wooden slabs are produced by almost 100 % renewable materials.

The indicator "Use of secondary materials" is a concrete value of how much material that is recycled from previous use or waste (scrap metal, broken concrete, broken glass, plastic etc) which are used as material. According to ISO 14021 which is the basis for EPDs, only pre-consumer and post-consumer materials are considered as recycled content or secondary materials. Internal scrap from its own production, is not considered in the use of secondary materials.

The indicator secondary materials do not make any difference if the materials is up – or downcycled, and can both be renewable and non-renewable, with or without energy content. The use of secondary materials is to some extent included in the greenhouse gas emission indicators, but this parameter is probably not enough to stimulate to more use of secondary materials in production of new materials. This parameter is important regarding secondary economy focusing on more reuse of existing resources. The same is the D-module in EPDs informing about the reuse/recycling-potential, but both because this information is based on scenarios for given markets, and that still it is quite few EPD that include this information, it is probably better to focus on the concrete values that Use of secondary materials represent.

Use of secondary materials is therefore an appropriate indicator to use for most material groups, with some exceptions. The most important exception is wooded products where it is more important to focus on how the wood is produced instead of if the product is based of secondary wooden materials. Another exception could be that the use of secondary materials is not always the most sustainable if the use of secondary materials leads to disproportionately long transport distances with high emissions.

At the same time the indicators have to reflect best practice in the Nordic countries – and therefore must be relevant for the specified materials and products.

Despite all these incompleteness's, a simplification were the single "Use of secondary materials" as a portion of the total weight is used as an indicator of Use of resources, unlike Ecoproduct that also include the parameter defining use of renewable and non-renewable materials.

Figures 2.16 – 2.21 present a survey of existing EPD and the level of used secondary materials.

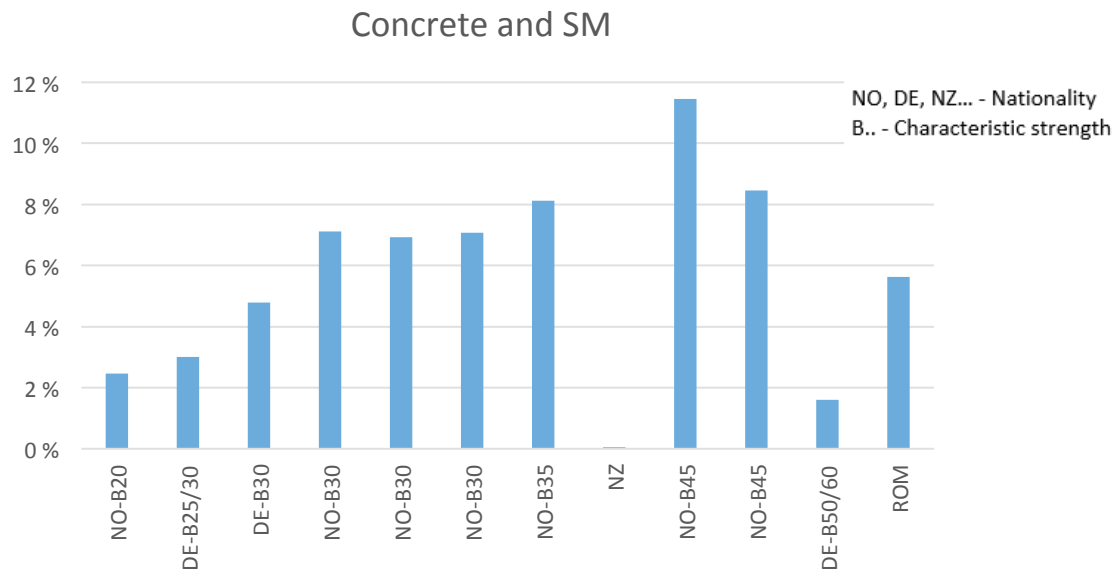


Figure 2.16 Comparison of Use of Secondary materials in concrete

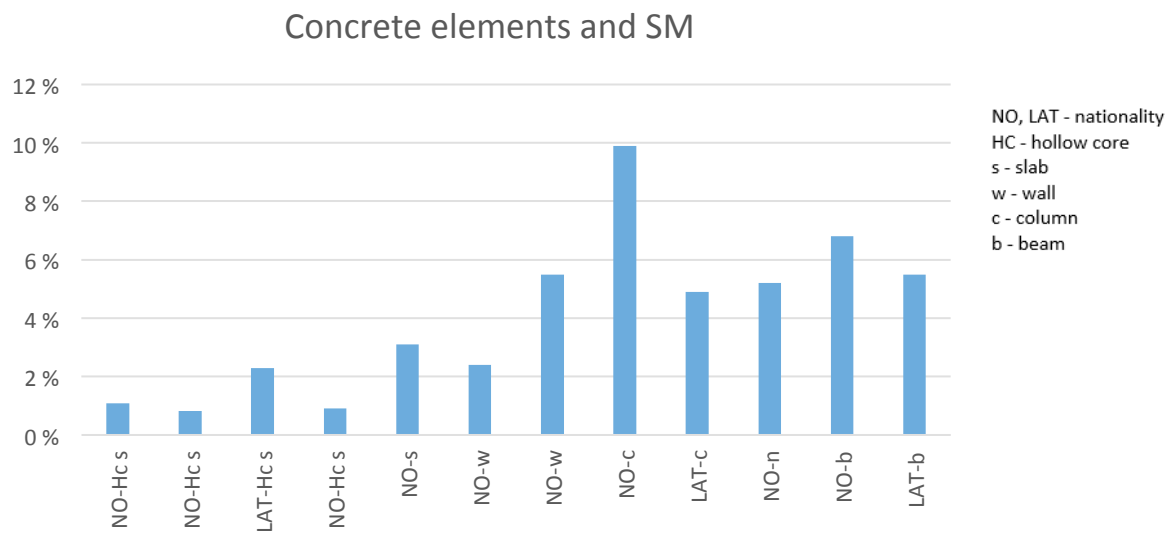


Figure 2.17 Comparison of Use of Secondary materials in concrete elements.

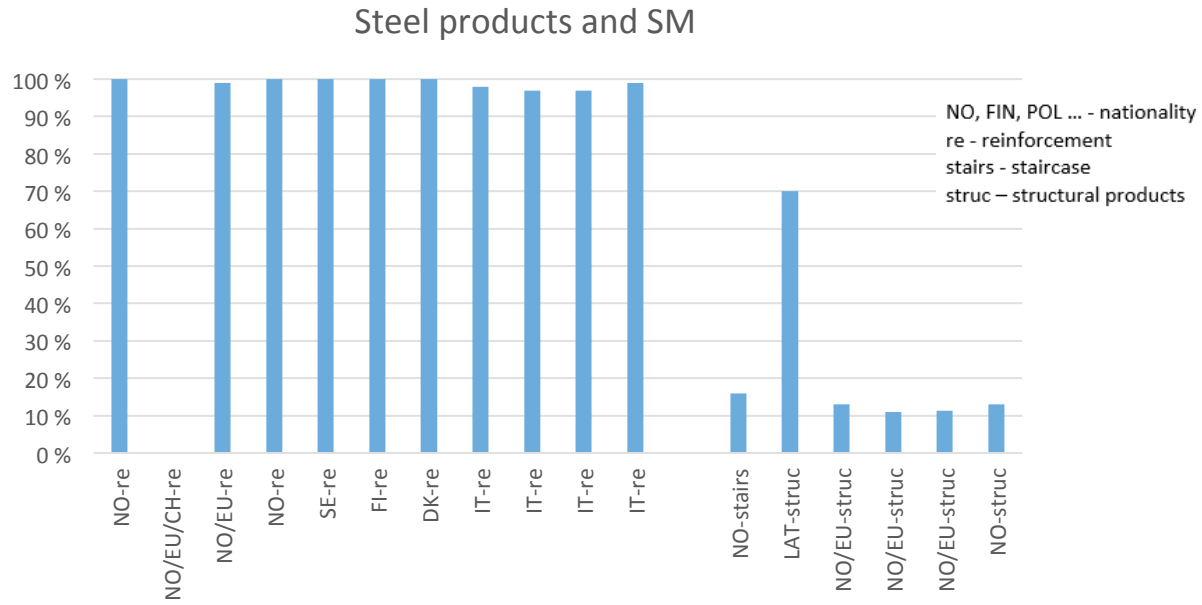


Figure 2.18 Comparison of Use of Secondary materials in steel products.

In the upper figure is a selection of EPDs for EPDs for various EPD-owners. In many of the EPDs, especially for the construction steel, and not reinforcement, it is referred that the fraction of recycled steel from European mills are 11-13 %, while some have not included this in their EPD. The Finnish EPD refers that average value is 20% for their Finnish steelmills that means that it is probably some varieties between the mills. The EPD for the Latvian producers assume 70 % use of secondary materials, also for European mills, which probably is overestimated.

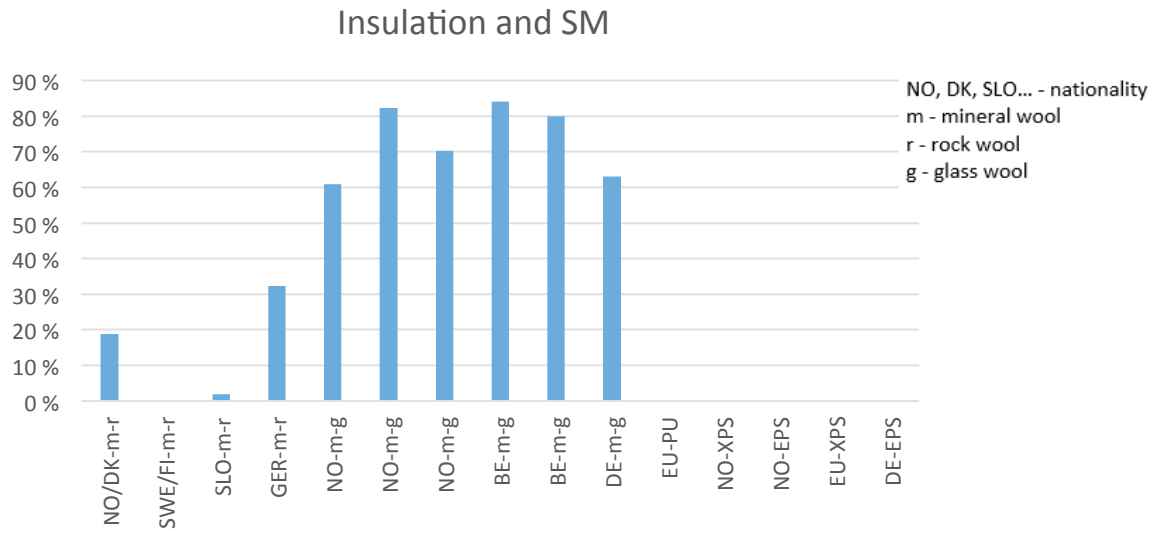


Figure 2.19 Comparison of Use of Secondary materials in insulation materials.

No known insulation products like PU, XPS and EPS with EPDs are based on any secondary materials. This means that it is not at this moment technical responsible to establish any Best Nordic Level for this product group. Regarding use of secondary materials.

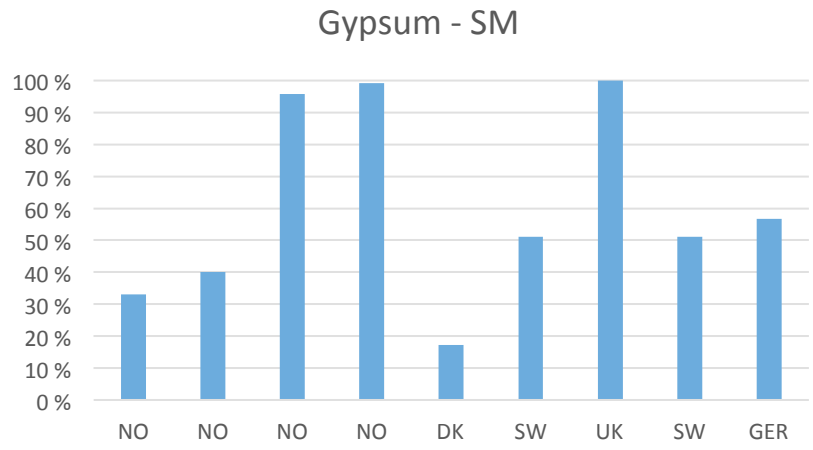


Figure 2.20 Comparison of Use of Secondary materials in gypsum boards.

Only one of 21 EPDs for windows includes information of use of secondary materials and this is PVC-windows represented by the European PVC Window Profiles Association. Even it is a very small selection of EPD, but representing a fairly large industry, it is an indication that there are some uses of secondary materials in PVC-windows.

The Best Nordic practice for windows with wooden frames should document that the wood used in the windows comes from certified forests and does not include any tropical wood.

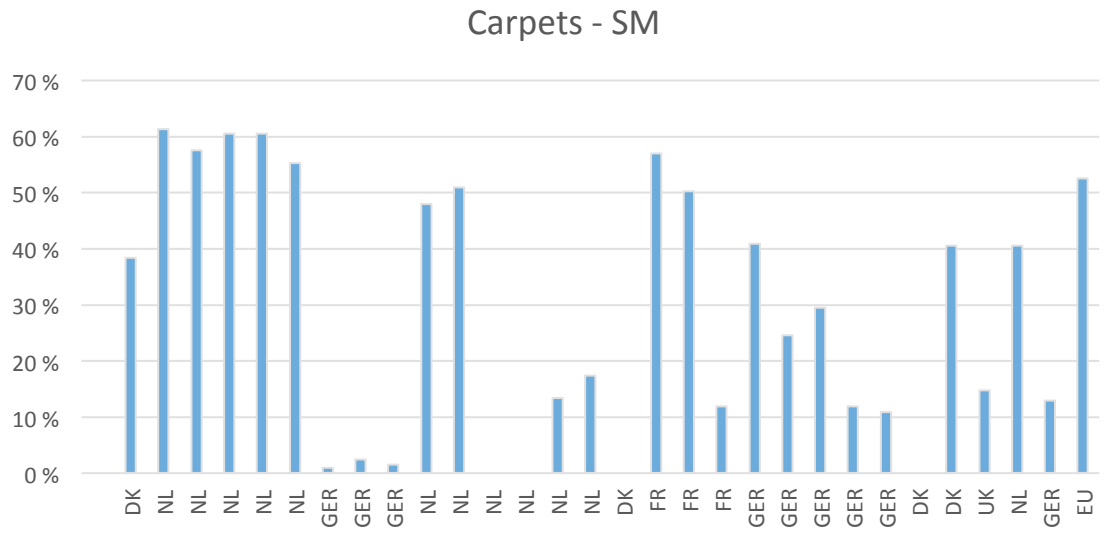


Figure 2.21 Comparison of Use of Secondary materials in carpets.

Floor coverings as laminate and rubber according to existing EPDs do not contain any secondary materials, while some EPDs for some few vinyl coverings indicates a percentage between 0 and 20 % while for linoleum varies between 0 and 40 %.

Based on this survey illustrated with Figures 2.16 – 2.21, a suggestion of reference values defining the level Best Nordic practice for Material Resources are given for some product groups in Table 2.9.

Table 2.9 Reference value s defining the level Best Nordic practice for Material Resources for some product groups

	Use of renewable materials [1]
Concrete	More than 5 % secondary materials
Precast concrete elements	More than 5 % secondary materials
Steel constructions	More than 20 % secondary materials
Steel reinforcement	More than 95 % secondary materials
Insulation (Mineralwool)	More than 15 % secondary materials
Insulation (EPS/XPS …..)	-
Gypsum building boards	More than 30 % secondary materials
Wooden based products	Certified forest and no tropical wood
Non-wooden window and doors	More than 0 % secondary materials
Roofing	More than 0 % secondary materials
Ceilings	More than 0 % secondary materials[2]
Carpets	More than 40 % secondary materials
Vinyl and linoleum	More than 15 %

[1] The levels of % of secondary materials are based on existing EPDs

[2] If not defined by any other product groups (for instance gypsum boards or wooden based products)

Another alternative to document that the indicator Use of Resources fulfill the Best Nordic level is the most ambitious level of Resources, the Green level, described in Ecoproduct.

Table 2.10 The three levels of the indicator Material resources

Best Nordic practice	Less than a given % of secondary materials or Certifies forest and no tropical wood
High ambitions	Verified declaration
Good ambitions	Self-declaration

2.4.3. Hazardous substances

Summary: The Best Nordic Practice and High ambition level are based on the ambitious levels for various Nordic assessment and labelling systems. The list of criteria is the same for all product groups. As a principle, all established major Nordic assessment and labelling systems can be used as documentation despite the minor deviations between the systems.

The Swedish BASTA [13], Building Material Assessment [14] and Sunda hus [15] focus primarily on harmful substances with fixed criteria for a list of given substances. More information about these systems is found in the report from WP1, "Nordic guide to sustainable materials. WP1-State of the Art".

The Accepted level in the Building Material Assessment (BVB) harmonizes with the BASTA-level, Sunda hus level B, and the Norwegian SINTEF Technical approval [16]. The criteria for the Nordic Ecolabel [17] are at least as strict as the Recommended level in BVB and Sunda hus level A in addition to more chemicals than included in the assessment system. The two most ambitious levels in the Norwegian Green Ecoproduct-level meet respectively the two most ambitious levels in this Nordic guide.

The levels are more or less the same for all types of products in the various declaration systems. The exception is Ecolabel that has some variation in criteria depending on type of product.

In the Nordic guide regarding Hazardous substances these existing declarations systems are used as the baseline for the definition of the three levels. The criteria and levels within each systems that makes the basis for the two ambition levels are more or less the same, with some minor differences between a few substances. As a principle when establishing these levels is that these established systems can be used as documentation despite the minor deviations between the systems.

Ecolabel, Sunda hus level A, and Building Material Assessment (BVB) Recommended all are at the highest ambitious level, the Best Nordic practice, and are the basis for the most ambitious level in the Nordic guide.

[13] www.bastaonline.se
[14] www.byggvarubedomningen.se (In Swedish)
[15] www.sundahus.se (In Swedish)
[16] www.sintefcertification.no/en-US
[17] www.ecolabel.no, www.ecolabel.se, www.ecolabel.fi, www.ust.is

BASTA, Building Material Assessment (BVB) Accepted, Sunda hus level B and SINTEF Technical approval are the basis for the High ambitions level. A comparison of BASTA, BVB, Sunda hus level B, SINTEF Technical approval and Ecolabel are given in Appendix 1.

Table 2.11 Criteria for the two most ambitious levels for Hazardous substances

	Best Nordic practice	**High ambitions**
H350 Carc. 1A or 1B	≤ 0,01 %	< 0,1%
H351 Carc. 1A or 1B	≤ 0,01 %	< 0,1%
H340 Muta. 1A or 1B	≤ 0,01 %	< 0,1%
H341 Muta. 2	≤ 0,1 %	1 %
H360 Repr. 1A or 1B	≤ 0,01 %	0,5 (0,1) %
H361	≤ 0,3 %	5 (3) %
H362 Lact	≤ 0,03 %	0,3 (0,1) %
Endocrine disruptors	≤ 0,01 %	< 0,1%
PBT	≤ 0,01 %	< 0,1%
vPvP	≤ 0,01 %	< 0,1%
Lead and compounds of lead	≤ 0,01 %	< 0,1%
Mercury and compounds of mercury	Prohibited	< 0,1%
Cadmium and compounds of cadmium	≤ 0,001 %	< 0,01%
H420 Harmful to the ozone layer	≤ 0,01 %	< 0,1%
Brominated flame retardants	< 0,1%	< 0,1%
H334 Resp	≤ 0,02 %	< 0,2 %
H317 Skin	≤ 0,1 %	< 1 %
H300 Acute Tox. 1	≤ 0,01 %	< 0,1%
H300 Acute Tox. 2	≤ 0,1 %	< 0,1%
H301 Acute Tox	≤ 1 %	< 3%
H310 Acute Tox. 1	≤ 0,01 %	< 0,1%
H330 Acute Tox. 1		< 0,1%
H311 Acute Tox	≤ 1 %	< 3%
H331 Acute Tox		< 3%
H370 STOT SE 1	≤ 0,1 %	< 1%
H371 STOT SE 2	≤ 1 %	< 25%
H372 STOT RE 1	≤ 0,1 %	< 1%
H373 STOT RE 2	≤ 1 %	< 25%
H400 Aqau Acute 1	≤ 2,5 %	< 25%
H410 Aqua Chronic 1	≤ 0,25 %	< 2,5%
H411 Aqua Chronic 2	≤ 2,5 %	< 25%
H413 Aqua Chronic 4	≤ 2,5 %	< 25%
H360 Repr. 1A	≤ 0,01 %	0,5 %

The Good ambition level is based on self-declaration as the other indicators. In addition this level is associated to the EU legislation and the Reach Candidate List of substances of very high concern, were the product should include less than 0,1 % substances on the Reach candidate lists.

Table 2.12 The three levels of the indicator Hazardous substances

Best Nordic practice	Substances less than limits in Table 2.11, Best Nordic practice or Ecolabel, BVB recommended, Green Ecoproduct level 1, Sunda hus level A
High ambitions	Substances less the limits in Table 2.11, High ambitions or BASTA, BVB accepted, Sunda hus level B, SINTEF Technical approval, Green Ecoproduct level 3 [2]
Good ambitions	Self declaration and less than 0,1 % substances on the Reach candidate lists

The three levels are based on international and national legislation, with either EPD or more sophisticated and detailed evaluation of hazardous substances as basis for the level each products has.

2.4.4. Emissions to indoor climate

Summary: The Best Nordic level corresponds to the criteria for Low Emission materials described in EN 15251.

The indicator "Emissions to indoor climate" is only relevant for products that affect the indoor environment. For Norwegian conditions, this is described as products on the inside of the vapour barrier or as a part of the vapour barrier system. For other countries, other references might be more appropriate to use based on the national construction methods.

The international standard EN 15251 is the basis for this indicator. The criteria for Low emission materials are:

Examined qualities for low emitting materials after 28 days	**[mg/m^{2}h]**
• The emission of total volatile organic compounds (TVOC)	< 0,2
• The emission of formaldehyde(HCOH)	< 0,05
• The emission of ammonia (NH3)	< 0,03
• The emission of carcinogenic compounds belonging to category 1A or 1B in Annex VI to Regulation (EC) No 1272/2008	< 0,005

Criteria for Emission Classes in the Finnish classification system

The Finnish emission classification of building materials [18] has three emission classes. Emission class M1 corresponds to the best quality and the low emitting class in EN 15251, and the most ambitious level in the Nordic guide-system. M2 correspond to the medium ambitious level. Classified materials have to fulfill the following criteria at the age of 4 weeks.

[18] www.m1.rts.fi

Table 2.12 Criteria for Emissions Classes

Examined qualities	M1 [mg/m²h]	M2 [mg/m²h]
The emission of total volatile organic compounds (TVOC). A minimum of 70% of the compounds shall be identified.	< 0,2	< 0,4
The emission of formaldehyde(HCOH)	< 0,05	< 0,125
The emission of ammonia (NH_3)	< 0,03	< 0,06
The emission of carcinogenic compounds belonging to category 1A or 1B in Annex VI to Regulation (EC) No 1272/2008 [1*]	< 0,005	< 0,005
Odour (dissatisfaction with odour shall be below 15 %)[2*]	Is not odours	Is not odorous

1* does not apply to formaldehyde
2* The result of sensory evaluation shall be at least + 0,0

Emission class M3 includes materials whose emissions exceed the values specified for materials in category M2.

Other testing methods might also be used, for instance GEV-Emicode [19] for flooring materials and the GUT label [20] for carpets. Ecolabel has emission criteria corresponding to low emitting materials for flooring products from 2015.

Some of these testing methods give the results in ug/m3, and as a part of revising the Norwegian BREEAM Nor, there have been made an comparison between the Finnish classification system and Emicode (SINTEF Building and research institute).

Based on this is the M1 level established as the minimum level, except for sealants were EC1 Plus is the minimum level.

Table 2.13 Comparison between Emissions Classes in M1 and Emicode EC 1 and EC1+ fra GEV-Emicode.

	Very small areas - 0,007 m2/m3		Small areas - 0,05 m2/m3		Floor/ceiling - 0,4 m2/3		Wall - 1 m2/m3	
	ug/m3	ug/(m2 h)	ug/m3	ug/(m2 h)	ug/m3	ug/(m2 h)	ug/m3	ug/(m2 h)
M1 - 28 days								
TVOC	20	188	20	1420	160	200	417	200
Formaldehyde	10	94	10	710	40	50	104	50
Ammonia	10	94	10	710	24	30	60	30
Cancinogenic	1	9	1	71	4	5	10	5
EC1 - 28 days								
TVOC	100	7100			100	125		
Formaldehyde	50 - 3 days				50 - 3 days			
Ammonia								
Cancinogenic	1				1			
EC1 Plus - 28 days								
TVOC	60	4260			60	75		
Formaldehyde	50 - 3 days				50 - 3 days			
Ammonia								
Cancinogenic	1	71			1	1,25		

[19] www.emicode.com
[20] http://license.gut-ev.de/index.asp

For some EPD-operators, like the Norwegian operator, it is mandatory to inform about indoor emissions in EPDs if it is relevant for the product. Information about indoor emissions is also included in the Swedish Building Product Assessment, Sunda Hus and in some extent in The Swan for some products.

The three levels regarding Indoor air emissions in the Nordic guide are as following:

Table 2.14 The three levels of the indicator Indoor air emissions

Best Nordic practice	Low emission level (according to EN 15251) Documentation as M1, EC1, GUT, Ecolabel or corresponding level based on these certification systems
High ambitions	Medium emission level Documentation as M2 or corresponding level based on this certification system
Good ambitions	Self-declaration

3. Accepted documentation

To meet the described levels several types of documentation can be used depending on the ambitious level and the sustainability indicator.

Table 3.1 Types of documentation depending on ambitious level and indicator

	Greenhouse gas emissions	Material resources	Hazardous substances	Emissions to indoor climate
Best Nordic practice	• Verified EPD • Green Ecoproduct	• Verified EPD • Green Ecoproduct • PEFC/FCS e.g certification for wooden based materials • The Swan •	• The Swan • Building Material Assessment Recommended • Sunda Hus level A • Green Ecoproduct level 1 • Safety Data Sheet • Verified EPD with additional information	• M1 • GEV Emicode EC1 and EC1 Plus • GUT • SINTEF Technical approval • Green Ecoproduct • The Swan (only flooring) • Verified EPD
High ambitions	• Verified EPD • The Swan	• Verified EPD • The Swan	• Building Material Assessment Accepted • BASTA • Sunda Hus level B • SINTEF Technical approval • Green Ecoproduct level 3 • Safety Data Sheet • Verified EPD with additional information	• M2 • CEV Emicode EC2 • Verified EPD
Good ambitions	• Building Material Declaration • Other self-declaration	• Building Material Declaration • Other self-declaration	• Safety Data Sheet • Building Material Declaration • Other self-declaration	• Self-declaration based on laboratory tests

Comments for the three ambition levels

Best Nordic practice

- Verified EPDs give information as basis for evaluation against the criteria level for Greenhouse gas emissions and Material resources
- Green Ecoproduct meets the criteria level for Greenhouse gas emissions
- Green Ecoproduct meets the criteria level for Resources as an alternative to "Use of secondary material" as described in the indicator
- Certification for sustainable foresting as PEFC/FCS meets the criteria for wooden based materials. The certification must also declare that the wood is not from tropical forests
- The Swan meets the criteria for Resources, Hazardous substances for all product groups

- Building Material Assessment Recommended, Sunda Hus level A and Green Ecoproduct level 1 (from 2016) meet the criteria for Hazardous substances for all product groups
- Safety Data Sheet and EPDs with additional information give information as basis for evaluation against the criteria level for Hazardous substances. The criteria level is given in Table 2.11, Best Nordic practice.
- The emission classification M1, GEV Emicode EC1 and EC1 Plus, GUT, SINTEF Technical approval and Green Ecoproduct meet all the criteria for Indoor emissions
- In 2015 The Swan meet the criteria for indoor air emissions for flooring products only
- Some verified EPDs (mostly Norwegian, but also others) give information as basis for evaluation against the criteria level for Indoor Air emissions (either as specified certification or emission levels)

High ambitions

- Verified EPDs and Swan certification meet the criteria for Greenhouse gas emissions and Material resources
- Building Material Assessment Accepted, Sunda Hus level B, SINTEF Technical approval, BASTA and Green Ecoproduct level 3 (from 2016) meet the criteria for Hazardous substances for all product groups
- Safety Data Sheet Safety Data Sheet and EPDs with additional information give information as basis for evaluation against the criteria level for Hazardous substances. The criteria level is given in Table 2.11, High ambitions.
- The emission classification M2 and GEV Emicode EC2 meet all the criteria for Indoor emissions
- Some verified EPDs (mostly Norwegian, but also others) give information as basis for evaluation against the criteria level for Indoor Air emissions (either as specified certification or emission levels)

Good ambitions

- Building material declaration and other self-declaration meet the criteria for Greenhouse gas emissions and Material resources
- Building material declaration, safety data sheet and other self-declaration give information as basis for evaluation against the criteria level for Hazardous substances
- Self-declaration based on laboratory tests meets the criteria for indoor air emissions

Appendix 1

Comparison between BASTA/BVB Accepted, SINTEF Technical approval and Ecolabel (Solid materials). Note that the chemical content verified by BVB Accepted and SundaHus applies to the product as delivered at the building site. For chemical products with SINTEF Technical approval, the threshold applies for the product in dry/cured state. For Nordic Ecolabeled product the chemical content in the product delivered at the building site and the chemical in the raw materials and used during the production process are also limited.

Category	**BASTA/BVB Accepted** Thresholds applies for the product as delivered at the building site.	**SundaHus 6.1: B assessment** Thresholds applies for the product as delivered at the building site.	**SINTEF Technical approval** For chemical products, the threshold applies for the product in dry/cured state	**Ecolabel solid materials and chemical products** Requirements to all chemicals used in the raw materials and during the production processes.
Carcinogens H351 H350	 1 weight% 0,1 weight%	 1 weight 0,1 weight%	 1 weight% 0,1 weight%	 0,01 weight % 0,01 weight %
Reproductive toxins H360 H361	 0,1 weight% 3 weight%	 Ch. prod:0,3 weight % Other prod: 0,1 weight% 3 weight %	 0,5 weight% 5 weight%	 0,01 weight % 0,01 weight %
Mutagen H340 H341	 0,1 weight% 1 weight%	 0,1 weight% 1 weight%	 0,1 weight% 1 weight%	 0,01 weight % 0,01 weight %
Harm to breast-fed babies H362	 0,3 weight%	 0,1 weight%	 0,1 weight%	 0,01 weight %
Endocrine disruptors	0,1 weight%	0,1 weight%	0,1 weight%	0,01 weight %
PBT	0,1 weight%	0,1 weight%	0,1 weight%	0,01 weight %
vPvB	0,1 weight%	0,1 weight%	0,1 weight%	0,01 weight %
Lead and compounds of lead	0,1 weight%		-	Forbidden in pigments or 0,01 weight %
Mercury and compounds of mercury	Forbidden			
Cadmium and compounds of cadmium	0,01 weight%			
Brominated flame retardants		-	0,1 weight%	Forbidden
Harmful to the ozone layer H420	0,1 weight%	0,1 weight%	0,1 weight%	0,01 weight %
Allergenic H334 H317	 0,2 weight% 1 weight%	 0,2 weight% 1 weight%	 1 weight% 1 weight%	Forbidden in indoor paints, otherwise the limits are dependent on the product group
Acute toxicity H300	The single ATE (Acute Toxicity Estimate)	Ch.prod: The single ATE Other prod:1 weight%	0,1 weight%	0,01 weight %

H310		Ch.prod: The single ATE Other prod:1 weight%	0,1 weight%	0,01 weight %
H330		Ch.prod: The single ATE Other prod:1 weight%	0,1 weight%	0,01 weight %
H301		Ch.prod: The single ATE Other prod:25 weight%	3 weight%	0,01 weight %
H311		Ch.prod: The single ATE Other prod:25 weight%	3 weight%	0,01 weight %
H331		Ch.prod: The single ATE Other prod:25 weight%	3 weight%	0,01 weight %
H302		Ch.prod: The single ATE	25 weight%	-
H312		Ch.prod: The single ATE	25 weight%	-
H332		Ch.prod: The single ATE	25 weight%	-
Toxicity after single exposure				
H370	1 weight%	1% weight%	3 weight%	0,01 weight %
H335		-	3 weight%	-
Toxicity after repeated exposure				
H372	1 weight%	1 weight%	3 weight%	0,01 weight %
Environmentally hazardous				
H400	25 weight%	25 weight%	25 weight%	0, 01 weight %
H410	2,5 weight%	2,5 weight%	0,25 weight%	0,01 weight %
H411	25 weight%	25 weight%	2,5 weight%	0,01 weight %
H412		25 weight%	25 weight%	0,01 weight %
H413	25 weight%	25 weight%	25 weight%	-
The Norwegian priority list	-	-	0,1 weight%	0,01
Other chemicals				Chemicals with no classification that are forbidden or restricted: Phthalates Biocides APEO (Alkylphenol Ethoxylates) Aziridin/polyaziridin Isotiazolinon Azo dyes Metal complex dyes