# Environmentally preferable choice of products
# The ECOproduct method

Building Research Design Guides 2011

470.112E

## 0 General

### 01 Contents

The ECOproduct method was developed to enable environmentally correct choice of products in a building project. This design guide describes how to use the method, which must be based on the Environmental Product Declaration (EPD). The design guide is for use by all operators in the building and construction industry, and presuppose a general knowledge of the EPDs; see Byggdetaljer 470.103 *Miljødeklarasjoner av byggevarer* [Building research guidelines 470.103: Environmental product declarations for building materials].

### 02 Definitions

- *EPD*: The environmental product declaration is a third-party verified EPD that complies with international standards ISO 21930 and/or NS-EN ISO 14025. The designation EPD is used in this design guide.
- *Third party:* person or body that is recognised as independent of the first party (supplier) and the second party (buyer interest) when the EPD is drawn up
- *Functional unit:* describes the function a product fulfils in a given time perspective. See also NS-EN ISO 14040.
- *CMR substances:* substances that have serious long-term effects on health and that are classified as carcinogenic, mutagenic, reprotoxic or chronically toxic
- *PBT substances:* poorly degradable (persistent) substances that accumulate in living organisms (bioaccumulative), and that have serious long-term effects on the health or are highly toxic to the environment (toxic)
- *vPvB substances*: very poorly degradable substances (very Persistent) that very easily accumulate in living organisms (very Bioaccumulative)
- *Environmental toxins*: substances classified as CMR, PBT and vPvB substances, and other substances that give similar cause for concern

### 03 References

Act relating to planning and processing of building applications – the planning part (PBA-P)
Forskrift om tekniske krav til byggverk (TEK10) med veiledning [Regulation on technical requirements relating to buildings (TEK10) with guidelines]
The Act relating to control of products and consumer services (Product Control Act)
The EC regulation relating to the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
EU Regulation on classification, labelling and packaging of chemicals (CLP Regulation)
Forskrift om klassifisering, merking mv. av farlige kjemikalier [Regulation relating to classification, labelling etc. of hazardous chemicals]
Forskrift om gjenvinning og behandling av avfall [Regulation relating to recycling and treatment of waste (the Waste Regulation)]
Forskrift om begrensning av forurensning [Regulation relating to limitation of pollution (Pollution Regulation)]
NS-INSTA 800 Cleaning quality – System for the establishment and assessment of cleaning quality
NS-EN ISO 14025 Environmental marks and declarations – Environmental declaration type III – Principles and procedures
ISO 21930 Sustainability in building construction – Environmental declaration of building products
NS-EN ISO 14040 Environmental management – Life cycle assessment – Principles and framework (ISO 14040:2006)
NS-EN 15251 Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics

Building Research Design Guides (in Norwegian only):

470.101 Livsløpsvurderinger av bygninger og bygningsmaterialer [Life cycle assessment of buildings and building materials]
470.103 Miljødeklarasjoner av byggevarer [EPDs for building products]
421.522 Bygningsmaterialer og luftkvalitet [Building materials and air quality]

501.107 Ren, tørr og ryddig byggprosess [Clean, dry and orderly building process]
501.108 Renhold i byggeperioden [Cleaning in the building period]
570.001 Dokumentasjon av egenskaper for byggprodukter [Documentation of properties of building products]
700.209 Prinsipper for miljøbevisst renhold. «Beste Praksis Renhold» [Principles of environmentally conscious cleaning. «Best Practice Cleaning »]
700.802 Miljøkartlegging og -sanering ved riving og ombygging [Environmental mapping and clearing in connection with demolition and rebuilding]
700.804 Planlegging av rivearbeider [Planning of demolition work]

# 1 Introduction

## 11 The method

The ECOproduct method is used to evaluate the environmental properties of a building product on the basis of an environmental product declaration (EPD). The method consists of a set of environmental parameters in the areas:

- indoor climate
- substances hazardous to health and the environment
- greenhouse gas emissions
- use of resources

The method is illustrated in Fig. 11. The various parameters are graded and weighted to an overall grade for each environmental area. Products are awarded the grades of red (poor/unacceptable), white (average) or green (good) in each of four environmental areas. No overall grade is awarded for the product.

The method is based on [822], and has been further developed in collaboration with Norsk Byggtjeneste AS, the organisation Grønn Byggallianse and Ecobox [821]. Norsk Byggtjeneste AS operates a database with products assessed according to the ECOproduct method [823]. The sub-area «release of particles and fibres» deviates from the description in [821].

## 12 Limitations

Testing for leakage to the ground and to water is relevant for some building products. This has not yet been included in ECOproduct.

It has proved difficult to establish reference values, as there are insufficient numbers of EPDs for each product type. Different methods of preparing EPDs, in particular the environmental load added for electricity consumption (electricity mix) will have a major bearing on the result for the sub-area energy, waste and the greenhouse effect. In many cases, data on the use of chemicals and emissions to indoor climate are also unavailable.

The method is applicable, but these limitations should be borne in mind when using it. More readily available environmental data will improve this situation.

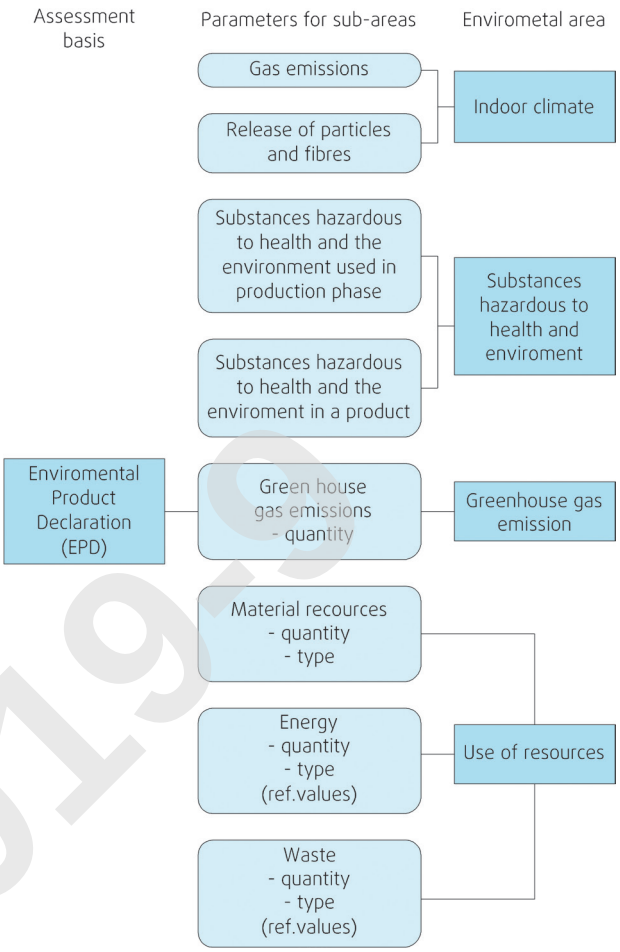


Fig. 11
Illustration of parameters and environmental areas

## 13 Use of ECOproduct as documentation

131 *Environmental requirements in TEK10.* An ECOproduct evaluation can be used to document the environmental properties in TEK10 and to choose the environmentally most favourable product on the market. The guidelines to Section 13.1 of TEK10 specify that pollution emissions shall be documented, but no maximum values are set. If a green or white grade is achieved for substances hazardous to health or the environment, this is consistent with the specification in the guidelines to Section 9.2 of TEK10, which focuses on avoiding high priority environmental toxins. TEK10 only has general requirements regarding greenhouse gas emissions and resource consumption.

132 *Requirements in SINTEF Technical Approval (TG).* SINTEF Technical Approval is a voluntary scheme for approval of building products which also includes requirements regarding environmental factors. The requirements regard declaring and in some cases avoiding high priority environmental toxins. These are the substances that are graded red in ECOproduct. Requirements regarding low-emission materials are made pursuant to NS-EN 15251, corresponding to a grade of green in ECOproduct.

Information shall include the products' recycling potential, and products that will become hazardous waste do not get TG. See Building Research Design Guides 470.103 for more information.

133 *Substitution principle* pursuant to the Product Control Act means that an enterprise that uses a product containing substances hazardous to health and the environment shall evaluate whether the product can be replaced with a less harmful substance. The ECOproduct method can be used to identify substances hazardous to health and the environment where substitution should be considered.

134 *Other environmental requirements.* In its environmental strategy [824], Statsbygg has stipulated requirements regarding environmentally correct use of materials. Emphasis is placed on using materials with the lowest possible greenhouse gas emissions and a minimum of substances hazardous to health and the environment. Materials from threatened species and from scarce and non-renewable resources shall also be avoided. These environmental requirements can be documented with ECOproduct.

### 14 Prioritisation of environmental areas

141 *General.* ECOproduct grades four main areas, with no internal weighting of the environmental areas. All the areas are prioritised in Norwegian and international environmental policy [825]. Reducing greenhouse gas emissions and the use of substances hazardous to health and the environment have high priority in both national and international environmental work.

142 *For materials that are exposed to the indoor air*, the indoor climate should receive highest priority, since this will affect the user throughout the materials' service life.

143 *Priority for different product groups.* The priorities given to environmental areas will have to vary from one material group to the next. Insulating materials, for example, often contain raw materials that are non-renewable and for which there is no good recycling solution at the end of their service life. Priority should then be given to the area's resource consumption. If substances hazardous to health and the environment are a «problem area» for a product group, this area should receive priority in connection with selection of products within this product group.

## 2 Use of the method

### 21 Mode of approach

ECOproduct is used as follows:

- Ask for an EPD for the product.
- Compare the data in the EPD with the criteria for each parameter in the ECOproduct method; see Fig. 11.
- Calculate the result for the different parameters.
- Aggregate the results of the parameters for the four environmental areas.

In some cases, documentation on the use of chemicals and on gas emissions and the release of fibres and particles to the indoor climate is also necessary. See points 32, 33 and 41. A knowledge and understanding of EPDs and other environmental documentation is required to perform an ECOproduct evaluation.

### 22 EPDs and evaluation of data

221 *Available EPDs.* Norwegian EPDs are available at www.epd-norge.no. An overview of other national EPD schemes is available at www.gednet.org. EPDs can also be requested directly from manufacturers.

222 *Functional unit.* To permit comparison of product EPDs, calculations must be made for a given functional unit, for example that a product serves a function for 60 years. If a product has a service life of 30 years and another of 60 years, it must be ensured that one replacement of the product with the shorter service life is taken into account, or alternatively that the data in the EPD is multiplied by 2.

223 *EPDs for other countries* are not always directly comparable with Norwegian EPDs. It is possible to make an ECOproduct assessment of them nonetheless. The EPD must satisfy NS-EN ISO 14025 and ISO 21930. If it does not, it should not be used.

In non-Norwegian EPDs, the energy utilisation of the product may be taken as a gain (deduction of energy used) in the EPD. In Norwegian EPDs, a gain on the energy utilisation of the product is assumed to benefit whatever makes use of the energy (the next product system, for example district heating). It is recommended that energy utilisation to be excluded from the evaluation. The assumed transport distances should also be investigated, and estimates made of transport distances to the building site in Norway. See Building Research Design Guides 470.101 for more information.

224 *Unavailable data.* Where relevant information is unavailable, the grade of red is applied. However an exception is made for indoor climate, as effect on indoor climate is not relevant for all materials.

### 23 Reference values

The parameters quantities of waste, energy and greenhouse gas emissions are based on comparison with a reference value. This value is the average of that for products with the same functional unit and makes it possible to say whether the product is better or poorer than average. Functionally identical products are not necessarily of the same material. It has proved demanding to establish good reference values that cover products with the same function, as there are few EPDs available at present.

When the method is used, it is recommended that reference values be requested from Norsk Byggtjeneste AS. If they are unavailable, an average of the various products considered being used can be taken as a starting point. To obtain a reference value for quantity of energy, the energy in KWh or MJ over the service life is aggregated. The same is done for greenhouse gas emissions, kg of $CO_2$ equivalent. For waste, the quantity of waste over the entire service life is aggregated. The quantity of waste shall include the final disposal of the product following replacement and demolition.

### 24 Example to illustrate the method

The four environmental areas in ECOproduct are de-

tailed in points 3–6. An example, Waterproofing roof membrane (Roofing 2), is used to illustrate each environmental area. Indoor climate is not assessed, as it is not relevant for this example. The example is summarised in point 7, where a comparison is made of three types of roofing.

# 3 Indoor climate

## 31 General

The category *Indoor climate* consists of information about gas emissions and release of particles and fibres. If the product is exposed to the indoor climate, this environmental area must be included.

## 32 Gas emissions

There are several systems for classifying impact on indoor climate. The one used in Norwegian EPDs was first developed by the Finnish Building Information Foundation (RTS) [826] and is included in NS-EN 15251, Annex C. The grade for gas emissions is awarded according to table 32.

Products assigned grade 1 are low-emitters without testing. Other materials must be tested for emissions. See Building Research Design Guides 470.103 and 421.522 for more information on emissions from building products.

Table 32
Criteria for judging the parameter *Gas emissions*

| Criteria | Assessment | Grade |
|---|---|---|
| Natural stone, marble, glass, metal, ceramic tiles etc. | Excellent | 1 |
| Very low polluting materials according to NS-EN 15251 | Good | 2 |
| Low polluting materials according to NS-EN 15251 or M1 classification | Average to good | 3 |
| | Average | 4 |
| | Borderline fair | 5 |
| M2 classification | Marginally acceptable | 6 |
| | Poor | 7 |
| M3 classification | Unacceptable | 8 |

## 33 Release of particles and fibres

Criteria for release of particles and fibres are based on measurement of the dust coverage percentage on hard surfaces and the dust index of carpets. The measuring method and requirements are described in accordance with NS-INSTA 800, D 1–4. Measurement of dust cover and release of fibres and particles for hard surfaces takes place with the aid of adhesive foil through which light is shone by a laser instrument before and after sampling. The measuring can take place while the product is in use in the building. The result is a dust coverage percentage that should be as low as possible. Table 33 gives the required levels of the dust coverage percentage and the dust index. The dust coverage percentage requirements in the standard for easily accessible hard floors are used as criteria for all hard and even surfaces, including walls and ceilings. For carpets and other structured surfaces where sampling by means of adhesive foil and pressure rolling is not appropriate, the dust index and sampling method specified for textile floorings are used.

The table indicates types of material that could achieve low dust coverage percentages (grades 1 and 2). Measurements must be taken for all other materials. It is important to take steps during the building and operations phase to prevent dust settling on surfaces and particles and fibres being released. This entails thorough cleaning of the building, measures to prevent release of fibres and dust (for example sealing of ceiling boards and using a binder on concrete to prevent dust) and facilitating good cleaning. See Building Research Design Guides 501.107, 501.108 and 700.209 for more information.

Table 33
Criteria for assessing the parameter *Release of particles and fibres*

| Criteria | Assessment | Grade |
|---|---|---|
| Stone, marble, glass, steel etc. | Excellent | 1 |
| Painted and dust-bound surfaces (plaster, concrete etc.) | Good | 2 |
| Dust level 5 according to NS-INSTA 800, D 1–4 | Average to good | 3 |
| | Average | 4 |
| | Borderline fair | 5 |
| Dust level 4 according to NS-INSTA 800, D 1–4 | Marginally acceptable | 6 |
| Poorer than Dust level 4 according to NS-INSTA 800, D 1–4 | Poor | 7 |
| | Unacceptable | 8 |

## 34 Overall grade

An overall grade is awarded for indoor climate as an average of the grade for *gas emissions* (table 32) and *release of particles and fibres* (table 33). The overall grade for indoor climate has the same scale as in tables 32 and 33. It is rounded off to the nearest whole grade.

# 4 Substances hazardous to health and the environment

## 41 General

The category *substances hazardous to health and the environment* consists of two parameters:

- substances hazardous to health and the environment in production
- substances hazardous to health and the environment in the finished product

The grade is estimated in point 46 and weighted together to a combined grade for substances hazardous to health and the environment. Information on substances hazardous to health and the environment in production and in the product will often be found in the EPD. Where documentation is not available, material safety data sheets must be requested.

## 42 Classification of substances

The classification of substances is based on a general classification made by Statistics Norway [827] and the Regulation relating to classification and labelling of hazardous chemicals. Risk phrases (R-phrases) are used in this classification, which is shown in tables 43, 462 and 463.

R-phrases will be replaced by other hazard labelling through the CLP Regulation. The CLP Regulation is the EU's new regulation for classifying and labelling substances. From 2015, all substances and mixtures must be labelled in accordance with the CLP. There will be a transitional arrangement in the period 2011–2015. The CLP Regulation has translated R-phrases into new risk phrases. See Building Research Design Guides 470.103 and www.klif.no for more information on the CLP Regulation.

## 43 Priority environmental toxins

– *Group 1* are priority environmental toxins that are to be phased out. See definitions in point 02. The substances have priority pursuant to the EU Chemicals Regulation, REACH, and are included in the priority list of the Norwegian Climate and Pollution Agency (KLIF). [828–830] provide an overview of environmental toxins of priority. For more information, see Building Research Design Guides 470.103 and www.klif.no.

Table 43
Groupings of R-phrases

| Main group | | R-phrases |
|---|---|---|
| 1 | Priority environmental toxins | *CMR:*<br>*Carcinogenic:* R40, R45, R49<br>*Reprotoxic:*<br>R60, R61, R62, R63<br>*Mutagenic:*<br>R46, R64, R68<br>PBT and vPvB: No R-phrases, see [830]<br>Priority list, see [828] |
| 2 | Acutely toxic (highly toxic/toxic) | R23, R24, R25, R26, R27, R28 and combination phrases such as R23/24 |
| 3 | Chronic effects | R33, R39, R41, R48, R65, R66, R68. and combination phrases such as R39/23 |
| 4 | Allergenic | R42, R43, R 42/43 |
| 5 | Environmentally harmful | R50, R52, R53, R54, R55, R56, R57, R58, R59 and combination phrases such as R50/53. |
| 6 | Hazardous to health:<br>– corrosive<br>– hazardous to health<br>– irritating | R20, R21, R22, R29, R31, R32, R34, R35, R36, R37, R38, R67 and combination phrases such as R36/38 |
| 7 | No labelling or labelled fire hazard | R1-R19, R30, R44 |

## 44 Other groups

– *Group 2* contains R-phrases associated with acute, highly toxic or toxic effects.
– *Group 3* contains R-phrases that indicate risk of chronic effects.
– *Group 4* contains R-phrases indicating that substances are allergenic.
– *Group 5* contains products or substances that are potentially environmentally harmful to plants or animals.
– *Group 6* contains R-phrases associated with other health hazard properties. In practice, many products will fall into this group.
– *Group 7* contains R-phrases associated with reactive properties such as fire or explosion risk. These have little relevance in ECOproduct. If the product is not labelled with R-phrases, it will fall into this group.

## 45 More than one classification

Some products can have more than one classification. Phrases 1–7 are then regarded as a hierarchy, i.e. if a product falls into more than one group, it is only counted in the first group to which it belongs, for the substance most hazardous to health and the environment. If, for example, a product is classified as both carcinogenic (group 1) and allergenic (group 4), it will be graded group 1.

## 46 Assessment

461 *The criteria in ECOproduct* take account of seriousness and quantity for the groups described in tables 462 and 463. The criteria for substances that only occur during production differ slightly from the criteria for those that remain in the product. In practice, it is possible to have a higher concentration of substances hazardous to health and the environment per functional unit during production than remaining in the product. See point 49 for a further explanation.

462 *Assessment of substances hazardous to health and the environment in production:*

> Are substances hazardous to health and the environment used in the production of the product?
> a) If yes: Find a grade in table 462 according to seriousness and quantity
> b) If no: Grade = 1

Table 462
Criteria for assessing substances hazardous to health and the environment in production that do not remain in the product

| Group \ Quantity | None | Traces | < 2 per cent by weight | ≥ 2 per cent by weight | ≥ 10 per cent by weight | ≥ 20 per cent by weight |
|---|---|---|---|---|---|---|
| 7) No labelling or labelled fire hazard | 1 | 1 | 1 | 1 | 1 | 1 |
| 6) Health hazard | 1 | 2 | 2 | 3 | 4 | 7 |
| 5) Environmental hazard | 1 | 2 | 3 | 4 | 5 | 8 |
| 4) Allergenic | 1 | 2 | 4 | 5 | 6 | 8 |
| 3) Chronic effects | 1 | 2 | 5 | 6 | 7 | 8 |
| 2) Acutely toxic (highly toxic/toxic) | 1 | 2 | 6 | 6 | 7 | 8 |
| 1) Priority environmental toxins | 1 | 2 | 7 | 7 | 7 | 8 |
| Priority list | 1 | 2 | 8 | 8 | 8 | 8 |

463 *Assessment of substances hazardous to health and the environment in the product:*

> Are there substances hazardous to health and the environment in the finished (cured) product?
> a) If yes: find a grade in table 463 according to seriousness and quantity
> b) If no: grade = 1

Table 463
Criteria for assessing substances hazardous to health and the environment remaining in the product

| Group \ Quantity | None | Trace | < 2 per cent by weight | ≥ 2 per cent by weight | ≥ 10 per cent by weight | ≥ 20 per cent by weight |
|---|---|---|---|---|---|---|
| 7) No labelling or labelled fire hazard | 1 | 1 | 1 | 1 | 1 | 1 |
| 6) Health hazard | 1 | 2 | 3 | 4 | 6 | 7 |
| 5) Environmental hazard | 1 | 2 | 4 | 5 | 7 | 7 |
| 4) Allergenic | 1 | 2 | 5 | 6 | 7 | 8 |
| 3) Chronic effects | 1 | 2 | 6 | 6 | 7 | 8 |
| 2) Acutely toxic (highly toxic / toxic) | 1 | 2 | 6 | 7 | 7 | 8 |
| 1) Priority environmental toxins | 1 | 2 | 7 | 7 | 7 | 8 |
| Priority list | 1 | 2 | 8 | 8 | 8 | 8 |

### 47 Quantity of substances hazardous to health and the environment in the product

If composite products are considered, for example building components that consist of several different materials, the concentration of substances hazardous to health and the environment shall be calculated for each material. For example, the concentration of substances hazardous to health and the environment in paint must be viewed in relation to the quantity of paint. The concentration in relation to the quantity of paint on wooden cladding is not to be calculated. This is in line with the pollution authorities' requirements about not diluting pollution.

### 48 Traces

Traces are substances that have not been actively added, and occur in very low concentrations in the product. Standard values laid down in the Pollution Regulations can be used to assess the substance in question. If the quantity is less than the standard value and the substance has not been actively added, it is a trace. All substances that have been actively added to the product and that occur in larger quantities, are defined in the group < 2 per cent by weight in tables 462 and 463.

### 49 Overall grade

If there are more substances hazardous to health and the environment in the final product than were used in the production, the result for the product forms the basis. If more substances hazardous to health and the environment have been used in production than remain in the product, an average is used as the grade.

The reason that a higher weighting is given to the use phase than the production phase is that it is less predictable. During production it is easier to control use, and hence the impact of substances hazardous to health and the environment. In the use phase one knows very little about the substances one is surrounded by, and cannot protect oneself in the same way. Nor is it possible to check how the product is treated when it becomes waste and whether hazardous waste is delivered for proper treatment.

> Example Roofing 2:
> Group 3 substances are used in production. The concentration is more than 2 per cent and less than 10 per cent by weight. This yields a grade of 6 according to table 462. The environmentally harmful substance in Group 5 occurs in the product. The substance has a concentration of more than 2 per cent and less than 10 per cent by weight, which results in Grade 5 according to table 463. When the grade of substances hazardous to health and the environment in the production process is higher than for substances hazardous to health and the environment in the product, an average is taken of the grade for production and product. This yields a grade of 5.5, rounded off to 6, which gives a white result with regard to substances hazardous to health and the environment.

## 5 Greenhouse gas emissions

Greenhouse gas emissions consist of only one parameter, emissions measured as $CO_2$ equivalents per functional unit. The assessment is made in relation to a reference value (see point 23 and table 5).

Table 5
Criteria for determining the parameter *Greenhouse gas emissions*

| 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 |

> Example Roofing 2:
> Roofing 2 has a greenhouse gas emission value of 60 % as reference value. This yields a grade of 3, green.

# 6 Use of resources

## 61 General

Use of resources covers material resources, quantity and type of waste and quantity and type of energy. These are calculated individually within each category and weighted together to a combined grade.

## 62 Material resources

From an environmental point of view it is most favourable to use recycled materials, as reduced extraction and use of natural resources reduces the burden on the environment. Next, use of renewable materials receives priority where this is possible. A minimum of non-renewable materials should be used (particularly scarce ones). This is in line with Norwegian and international environmental policy (see point 141).

The type of material resources is determined according to table 62. Here it is necessary to review all the raw materials in an EPD (from cradle to grave) and classify the type of raw materials oneself. The proportion of each type of material resource is converted into a percentage of total material resources.

Table 62
Criteria for determining the parameter *Type of material resources*. The figures in the calculation are taken from the example Roofing 2.

| Criteria (% of reference value) | Assessment | Grade | Total |
|---|---|---|---|
| Re-use | Excellent | 1 | 0 % |
| Recycled | Good | 2 | 0 % |
| Sustainably renewable (e.g. wood) | Average to good | 3 | 6 % |
| – | Average | 4 | – |
| Non-renewable (e.g. stone) | Borderline fair | 5 | 49 % |
| – | Marginally acceptable | 6 | – |
| (e.g. coal) | Poor | 7 | – |
| Non-sustainably renewable (e.g. oil) | Unacceptable | 8 | 45 % |
| **Grade** | | | **6.2** |

Example for Roofing 2:
In the course of the life cycle of a product for Roofing 2, 50 % recycled materials are used, 6 % sustainably renewable, 49 % non-renewable and 45 % non-sustainably renewable. The total grade will then be calculated as follows:
$0.06 \cdot 3 + 0.49 \cdot 5 + 0.45 \cdot 8 = 6.2$

## 63 Type of energy

The type of energy is ranked according to whether the energy source is renewable or not. The quantity available and possibility of using the energy source are also taken into account [822]. The potential for making use of sun and wind is not fully utilised. These energy sources are also regarded as relatively simple to utilise to a greater extent. Biomass is regarded as less readily available than the previous sources. Coal is not renewable and there are reserves sufficient for about 220 years, while there are oil reserves for 24 years. Coal therefore has a somewhat higher ranking than oil. The ranking of energy sources does not take into account the consequences of developing renewable energy, such as incursions into the landscape (wind) and use of land area (sun).

The result for each type of energy is calculated according to how large a percentage is used of the various energy sources, in the same way as for material resources (see table 63).

Table 63
Criteria for determining the parameter *Type of energy source*. The grade calculated for Roofing 2 is in the right-hand column.

| Criteria (% of reference value) | Assessment | Grade | Total |
|---|---|---|---|
| Sun, wind | Excellent | 1 | 0 % |
| Hydropower, wave energy, geotechnical, tidal energy | Good | 2 | 21 % |
| Biomass | Average to good | 3 | 1 % |
| – | Average | 4 | – |
| – | Borderline fair | 5 | – |
| – | Marginally acceptable | 6 | – |
| Coal | Poor | 7 | 6 % |
| Oil, natural gas, nuclear power | Unacceptable | 8 | 72 % |
| **Grade** | | | **6.6** |

Example Roofing 2:
The energy consumption for roofing and the distribution of the distribution of different energy sources is: 72 % oil, gas, uranium etc., 6 % coal, 21 % hydropower, 1 % bioenergy.
$0.72 \cdot 8 + 0.06 \cdot 7 + 0.21 \cdot 2 + 0.01 \cdot 3 = 6.6$.
This result is used with the result from point 64 for a result for the sub-area energy.

## 64 Quantity of energy

The quantity of energy is considered in relation to reference values (see point 23). The criteria are shown in table 64.

Table 64
Criteria for determining the parameter *Quantity of energy*

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

Example Roofing 2:
Roofing 2 has energy consumption that is 60 % of the reference value. This yields a grade of 3. The grade is used together with the result in point 63 for a combined result for the sub-area energy (point 67).

## 65 Type of waste

According to the authorities' objectives, waste for reuse or material recycling is preferable [825]. Next comes waste for energy recovery and landfilling. Hazardous waste is the least favourable from an environmental point of view because the consequences of inappropriate treatment are greater than for other types of waste. On the basis of information about the type and quantity of waste that is produced in the course of the life cycle of the product, including final disposal, a percentage distribution is made. The current practice for products undergoing disposal is described in Building Research Design Guides 700.804. The results are assessed according to table 65.

Table 65
Criteria for determining the parameter *Type of waste*. The grade calculated for Roofing 2 is in the right-hand column.

| Criteria | Assessment | Grade | Total |
|---|---|---|---|
| Re-use | Excellent | 1 | 0 % |
| Material recycling | Good | 2 | 0 % |
| Material recycling of a lower quality | Average to good | 3 | 3 % |
| Energy recovery | Average | 4 | 1 % |
| – | Borderline fair | 5 | – |
| – | Marginally acceptable | 6 | – |
| Landfills | Poor | 7 | 74 % |
| To hazardous waste treatment | Unacceptable | 8 | 21 % |
| **Grade** | | | **7.0** |

Example Roofing 2:
The waste generated in the course of the life cycle of Roofing 2 consists of 21 % hazardous waste, 74 % to landfilling, 1 % to energy recovery and 3 % to material recycling of lower quality. The grade for this area is then calculated as follows:
0.03 · 3 + 0.01 · 4 + 0.74 · 7 + 0.21 · 8 = 7 i.e. poor.

## 66 Quantity of waste

The quantity of waste is considered in relation to reference values (see point 23). Table 66 is used to determine the grade.

Table 66
Criteria for determining the parameter *Quantity of waste*

| 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 |

Example Roofing 2:
The roofing has a quantity of waste that is 45 % of the reference value, which results in a grade of 3.

## 67 Combining the area use of resources

When the parameters have been assessed, they are combined into an overall assessment of the area use of resources:
– material resources
– energy
– waste
The result for material resources is calculated in point 62. The following are done for energy and waste:
– Energy: The results of point 63 and point 64 are multiplied together. The result is found in table 67 a.

Example Roofing 2:
The result for Roofing 2 is 6.6 · 3 = 19.8. According to table 67 a this results in a grade of 3.

– Waste: The results of point 65 and point 66 are multiplied together. The result for Roofing 2 is 7·3 = 21. According to table 67 a this results in a grade of 3.

Table 67 a
Table for calculating the result of the sub-area *Energy and waste*

| From | To: | Assessment | Grade |
|---|---|---|---|
| 1 | 3.15 | Excellent | 1 |
| 3.2 | 12.75 | Good | 2 |
| 12.8 | 22.35 | Average to good | 3 |
| 22.4 | 31.95 | Average | 4 |
| 32 | 41.55 | Borderline fair | 5 |
| 41.6 | 51.15 | Marginally acceptable | 6 |
| 51.2 | 60.75 | Poor | 7 |
| 60.8 | 64 | Unacceptable | 8 |

The result for the sub-area resources is an average of material resources, energy and waste (see table 67 b).

Table 67 b
Result for the sub-area *Resources* calculated for Roofing 2

| Result | Grade |
|---|---|
| Raw materials | 6.2 |
| Energy | 3 |
| Waste | 3 |
| **Average** | **4** |

Example Roofing 2:
The average of the sub-areas results in the grade 4 = white.

# 7 Choice of product – roofing

## 71 Summary of results

711 *Functional unit* is 1 m$^2$ roofing installed and maintained for 60 years. Three different roofings are compared. One replacement is assumed for each of the roofings in the course of their service life. The calculation for Roofing 2 is used as an example in the other points in this design guide and the results, including sub-areas, are summarised in table 711. Impact on indoor climate is not relevant for this type of product.

Table 711
Comparison of three roofings. The result for sub-areas is included for Roofing 2.

| Environmental areas with sub-areas | | Roofing type 1 | Roofing type 2 Result sub-areal | | Roofing type 3 |
|---|---|---|---|---|---|
| Sub-stances hazardous to health and the environ-ment | In produc-tion |  | 6 |  |  |
| | In the product | | 5 | | |
| Use of resources | Material resources |  | 6 |  |  |
| | Energy | | 4 | | |
| | Waste | | 2 | | |
| Green-house gas emissions | Green-house gas emissions |  | 4 |  |  |
| Indoor air | Gas emis-sions | Not relevant | | | |
| | Release of particles of fibres | | | | |

712 *Results for Roofing 2:* A grade of 6 is assessed in point 49 for substances harmful to health and the environment. This yields the result white. The result for use of resources is the average of material resources, energy and waste, which is calculated in point 67. The result for the area resources is 4, which results in a grade of white. Greenhouse gas emissions are calculated in point 5. The product gets a grading of 3, green.

713 *Roofing 1* has a harmful substance in production, but in very low concentrations, which results in grade 3. A plasticiser, which is a priority environmental toxin, is used in the product. Since the grade for the product is higher than for the production, this results in the grade 7 (red) for substances hazardous to health and the environment in the product. Non-renewable material resources and non-renewable energy are used in the roofing. The roofing has no good recycling option. This means that it is graded red for use of resources. A grade of white is given for greenhouse gas emissions.

714 *Roofing 3* has limited harmful substances in production, but a priority environmental toxin in the product. This yields a grade of red for substances hazardous to health and the environment. Use of resources is graded white, and greenhouse gas emissions green.

715 *Comparison*:
- There is no question of selecting Roofing 1 since it comes out worst in two areas.
- Roofings 2 and 3 have the same properties for use of resources and greenhouse gas emissions.
- Roofing 2 is better than Roofing 3 in use of chemicals.

716 *Conclusion:*
- Since a problem environmental toxin is used in Roofing 3, priority is given here to Roofing 2.

# 8 References

## 81 Preparation

This design guide has been revised by Silje Wærp. It replaces the design guide of the same number that was published in 2002. The project manager was Henning Vik. Translation by: Beverley Wahl, MSTF. The technical editing was completed in June 2011.

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