Environmental Product Declaration

In accordance with ISO 14025 and EN 15804 for:

Flexible sheet for waterproofing - Alkorplan F (1,2 mm / 2,10 m)

Renolit

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ECO PLATFORM EPD EN 15804 VERIFIED

1. General Information

This document applies to Renolit Alkorplan F plastic sheet for roof waterproofing manufactured by Renolit in Sant Celoni, Spain. This Environmental Product Declaration is in accordance with ISO 14040 [1], 14025 [2] and 14044 Standards [3]. In addition to the general requirements for LCAs, this assessment is in accordance with the general programme instructions from the International EPD® System [4], and more specifically the requirements and structure of the Product Category Rules (PCR) for "Construction products and construction services (v2.2)" [5].

2. Company and product information

2.1 Company description

'Re*nolit Waterproofing'* is the second largest manufacturer of synthetic single ply membrane in Europe. The brand name ALKOR, which is the subject of this EPD, is a thermoplastic membrane based on PVC-P.

The production plant of Renolit Iberica is externally verified for its environmental management system in accordance with ISO 14001. Health and safety of the workers are furthermore subject to monitoring and external control according national legislation.

Production Centre: RENOLIT IBERICA S.A. - Carretera del Montnegre, s/n - 08470 San Celoni – España. http://www.renolit.com

2.2 Product specification

Renolit's plastic sheets are used for roof waterproofing. Renolit Alkorplan F is a single ply multi-layer plastic sheet for roof waterproofing based on polyvinyl chloride (PVC) with a laminated polyester fleece. Renolit Alkorplan F plastic sheets for roof waterproofing are available in different thicknesses. This EPD focuses on the 1.2mm thickness and 2100mm width variant.

Renolit's sheets have been used throughout the world for almost 40 years, waterproofing flat roofs in both new construction and renovation projects for nearly all building types. The roofing membranes can be grouped in the European Standards for plastic and rubber sheets: the EN-13956 [6] and EN-13707 [7]. The UN CPC code of this group is 36390: plates, sheets, film, foil and strip, of plastics.

This EPD describes the environmental impacts of *1 square meter of flexible sheet for roof waterproofing with a thickness of 1.2mm.*

Declaration of Performance	Unit	Alkorplan F
External fire performance (EN13956)		F_{roof}
Reaction to fire (EN 13501-1)		E
Water tightness (EN 1928)		Pass
Tensile force (EN 12311-2/A)	N/50 mm	>= 1050
Elongation (EN 12311-2/A)	%	>= 15
Tensile stress (EN 12311-2/B)	N/mm^2	n.r.
Elongation (EN 12311-2/B)	%	n.r.
Resistance to static loading (EN 12730/B and C)	kg	>= 20
Resistance to impact (EN 12691/A)	mm	>= 650
Resistance to impact (EN 12691/B)	mm	>= 2000
Tear resistance (EN 12310-2)	N	>= 200
Joint peel resistance (EN 12316-2)	N/50 mm	>= 200
Joint shear resistance (EN 12317-2)	N/50 mm	>= break
Artificial ageing (EN 1297)		Grade 0
Foldability at low temperature (EN 495-5)	°C	<= - 25 °C
Dangerous substances		Conform
Dimensional stability (EN 1107-2)	%	<= 0,3
Bitumen compatibility (EN 1548)		n.r.
Resistance to root penetration (for green roofs; EN 13948)		n.r.
Ozone resistance (EN 1844)		pass

The Froof is a European Union code to indicate the External fire performance that is in accordance with the EN13956. Tensile stress and elongation norms can be subdivided into two categories: homogeneous sheets (B) and reinforced sheets (A). This distinction is also included in the table above.

The abbreviation n.r. indicates that the declaration of performance category is not relevant for the product.

2.3 Base materials

The base raw materials for Renolit Alkorplan F plastic sheet for roof waterproofing are:

- Polyvinyl chloride (PVC) – 60-70%
- Plasticiser (Phthalate plasticiser) – 15-20%
- Stabilisers (UV/heat) – 1–2 %
- Chalk – 5-10%
- Flame retardant (inorganic) – <1%
- Reinforcing material, embedded polyester scrim – 5-10%
- Colour pigments - <1%

The recipe contains no hazardous substances. In accordance with current knowledge, this product contains no substances of very high concern (SVHC) on the /REACH Candidate List/ published by the European Chemicals Agency in a concentration exceeding 0.1 % (by unit weight).

2.4 Manufacturing

Renolit Alkorplan F plastic sheet for roof waterproofing are manufactured in the following steps:

- Dosing and mixing of various raw materials in powder and liquid form in a dry blend
- Plastification of this dry blend in an extruder
- Inserting this plasticised melt between a system of rolls (calender process) to obtain a layer or inserting this plasticised melt through a die (extrusion process) to obtain a layer
- Heat fusing of several layers obtained by the previous process with inserting of a polyester scrim, on a lamination machine
- Cutting on width and roll length and winding onto cardboard core
- Labelling and palletising

Production waste is recycled back into the manufacturing process. Production waste is treated like a normal raw material as described in the externally verified quality management

The waterproofing sheets are manufactured in continuous processes as illustrated below:

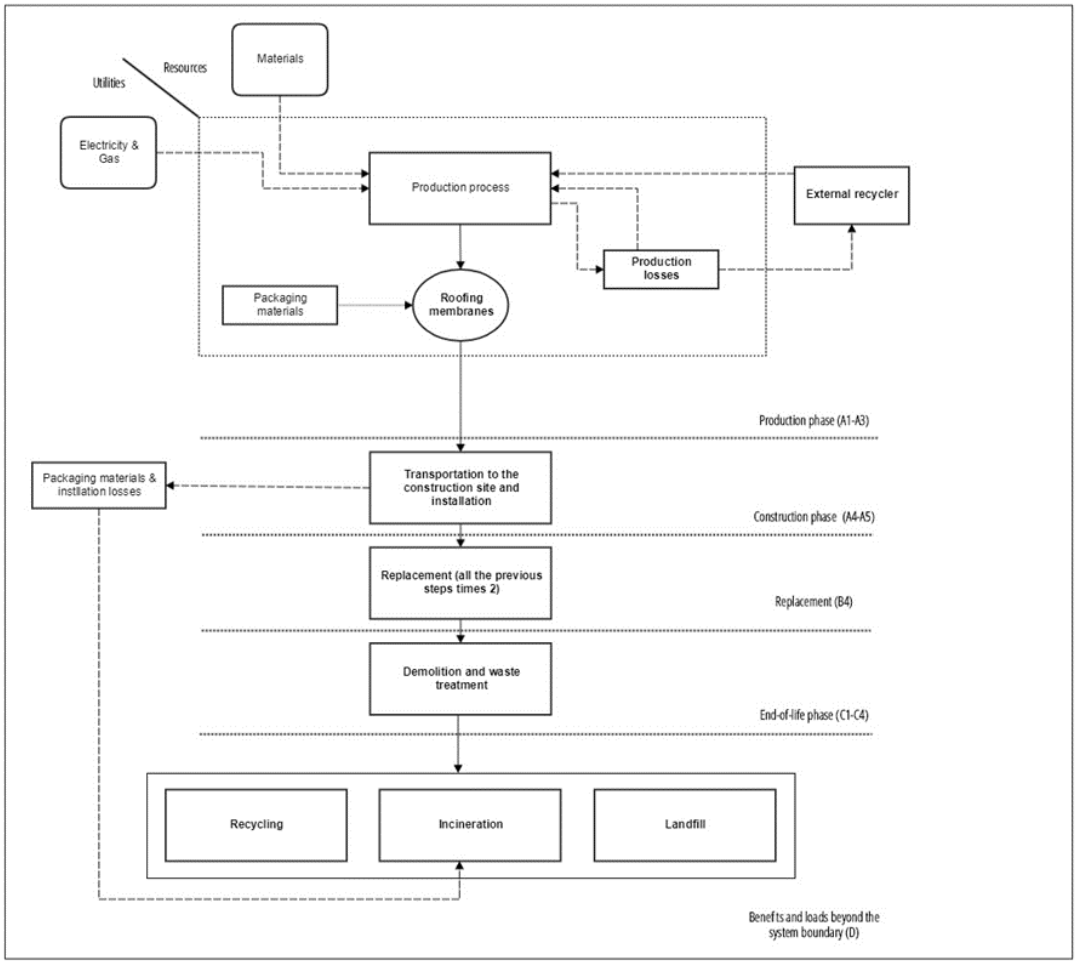

Figure 1: Process tree of one m^2 of Alkorplan F.

2.5 Product Application

Renolit Alkorplan F plastic sheet for roof waterproofing is used as an exposed sheet in a single ply adhered roofing system. The slope of the roof is limited by the required external fire performance of the roof system.

In order to withstand wind uplift, single ply mechanically fastened plastic sheets are loose laid and mechanically fastened with overlap. The sheets are fastened by polypropylene thermal breaks (17 grams of polypropylene and 4 carbon steel screws (80mm and 5.5 diameter). The welding between sheets is done by heat (0,01kWh per m^2).

2.6 Delivery status

Individual rolls on cardboard core are partially wrapped in PE foil and palletised. A protection PE foil is laid over the pallet and held together with PE straps. All packaging material can be sorted and collected for recycling.

The products are delivered palletised.

Thickness	Width	Packaging
1,2 mm	2,10 m	P11RL20

P11RL20 : 11 rolls of 20 running meters on a pallet

3. Functional unit

3.1 Functional Unit

The functional unit has been defined as follows: *the production, installation - including fasteners & losses - and waste processing of 1 m^2 plastic sheet for roof waterproofing, with a reference building service life of 90 years.*

Description	Value	Unit
Declared unit	1	m^2
Thickness	1,2	mm
Final weight	1,45	kg/m^2

The reference service life (RSL) of Renolit's plastic sheets for roof waterproofing is set at 30 years. This reference service life is based on internal and external accelerated testing and audits of installed projects. The British Board of Agrément confirmed this reference service by granting Technical approval, providing that the quality of the project and in-use conditions of use are respected. The latter is relevant, since the RSL is dependent on the properties of the product and in-use conditions. This also means that 2 renewals will be necessary during the reference building service life of 90 year.

3.2 System boundary

Type of EPD: Cradle to gate (with options)

The system boundaries of the EPD follow the modular construction system described by EN 15804. The LCA takes into account the following modules:

3.2.1 Production stage (A1-A3)

This includes three modules, A1, A2 and A3, concerning the extraction and processing of raw materials, transport and manufacturing, respectively.

3.2.2 Construction stage (A4-A5)

A4. This includes transportation from the manufacturing plant in Sant Celoni to the construction site. A distance of 800km, by road, has been assumed.

Parameter	Value	Unit
Vehicle type	Truck	-
Fuel type and consumption	0,032164	liter / tkm
Capacity use (including empty returns)	50	%
Bulk density of transported products (packaging included)	1,62	Kg per m^2 (thickness 1.2mm)

A5. Mechanically fastened sheets: 4 fasteners per m2, consisting of 17 grams polypropylene and 14 grams of carbon steel per fastener. To apply the fasteners, 0,010 kWh per m^2 is used. Additional material consumption due to overlaps (8%) and installation losses (3%) during the installation process is accounted for.

Together with the installation losses, packaging materials are for 100% collected and processed for energy recovery. For these materials a distance of 50 km is estimated from the construction site to the nearest municipal waste incineration facility.

Parameter	Value	Unit
Vehicle type	Truck	-
Fuel type and consumption	0,032164	liter / tkm
Capacity use (including empty returns)	50	%

Products (packaging and installation losses only)	0,21	Kg per m² (thickness 1.2mm)

3.2.3 Replacement stage (B4)

In order to conform to the building service life of 90 years, each roofing membrane with a service life of 30 years requires two renewals. This means that the environmental impact related to production (A1-A3), transportation to the production site (A4) and installation (A5) of two additional roofing membranes is reported in this module. Simply put, the replacement phase (B4) consists of the environmental impact as a result of the modules A1-A5 times two, with everything that it implies:

- Product manufacturing
- Manufacturing of the components and ancillary materials
- Transport to the customer
- Energy consumption, installation losses and additional materials during installation
- Management of waste from packaging and installation losses.

The subsequent end-of-life stage is also declared for a reference service life of 90 years.

3.2.4 End of life stage (C2-C4)

C2. A transport distance of 800 km from the building site to the recycler was taken into account [8].

Parameter	Value	Unit
Vehicle type	Truck	-
Fuel type and consumption	0,032164	liter / tkm
Capacity use (including empty returns)	50	%
Bulk density of transported products	1,45	Kg per m² (thickness 1.2mm)

C3/C4. Mechanically fastened sheets are easily removed, and are therefore relatively straightforward to recycle during the waste treatment stage (100% recyclable). It is, however, assumed that 10% of the sheet is lost during the -granulation process. This 10% loss is transported to a landfill (50km).

Alkorplan F	Value	Unit
Collected separately	1,45	kg
Collected with mixed construction waste	0	kg
For re-use	0	kg
For recycling	1,305	kg
For energy recovery	0	kg
For final disposition	0,145	kg

3.2.5 Benefits and loads beyond the system boundary (D)

Based on the PVC and PES content of the sheet, the amount of avoided virgin material has been determined at:

Alkorplan F	Unit (kg)
Final weight	1,45
Avoided PES	0,07
Avoided PVC	0,81

3.3 Data quality and allocation

To simulate the product stage, data recorded by Renolit from production year 2014 were used. All other relevant background data sets were taken from generic data not older than 10 years.

The primary data provided by Renolit Belgium derive from the production plant: Renolit Iberica. All background data records were retrieved from the Ecoinvent database (Version 3.2).

The average Spanish electricity mix with a medium voltage is used at Renolit's production site in San Celoni (Spain), together with natural gas. Corresponding Ecoinvent records were used.

3.3.1 Cut-off criteria

All data was taken into account (e.g. recipe constituents, thermal energy used, electricity used). Transport expenses were considered for all inputs and outputs. The manufacturing of the production machines and systems and associated infrastructure was not taken into account in the LCA.

3.3.2 Allocation rules

Allocation issues occur within the *cradle-to-gate* and *gate-to-cradle* boundaries.

Cradle-to-gate

A mass allocation procedure regarding the roofing sheet under study and other products manufactured in the plant has been followed.

Within the cradle-to-gate system boundaries only closed-loop recycling takes place. That is: scrap materials from the production process are used as raw input materials, thereby avoiding the need for additional raw materials. Since the environmental burden of this production waste was already accounted for in the previous product, internally recycled

(i.e. closed-loop) materials carry only the environmental loads of the reprocessing effort

Gate-to-cradle
Within the gate-to-cradle system boundary, some of the product (PVC and PES content) is recycled at the end-of-life to an unknown destination, i.e. an *open loop* system. Because the products reach an end-of-waste status after being reprocessed, the environmental impact of the recycling process is allocated to the preliminary life cycle, i.e. the product under study.

3.3.3 Comparability
Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to EN 15804 and the building context, respectively the product-specific characteristics of performance, are taken into account.

4. LCA: Results
The results displayed below apply to 1 m^2 Renolit's Alkorplan F, with a thickness of 1,2mm.

Description of the system boundary (X = Included in LCA; MND = Module Not declared)																
Product stage			Construction process stage		Use Stage							End of life stage				Benefits and loads beyond the system boundaries
Raw material supply	Transport	Manufacturing	Transport	Construction installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	MND	MND	MND	X	MND	MND	MND	MND	X	X	X	X

	Unit	A1-A3	A4	A5	B4	C2	C3	C4	D
GWP	kg CO2-Eq.	8,10E+00	2,37E-01	5,74E-01	1,78E+01	6,51E-01	8,93E+00	3,13E-02	-6,56E+00
ODP	kgCFC11-Eq,	1,51E-06	4,32E-08	2,58E-08	3,16E-06	1,19E-07	9,18E-07	1,33E-09	-4,83E-09
AP	kgSO2-Eq	2,46E-02	7,98E-04	2,71E-03	5,62E-02	2,58E-03	4,28E-02	3,61E-05	-1,77E-02
EP	kg(PO4)3--Eq,	5,52E-03	1,29E-04	4,84E-04	1,23E-02	4,49E-04	5,03E-03	1,12E-05	-2,07E-03
POCP	kgEthen-Eq,	2,53E-03	3,99E-05	1,98E-04	5,54E-03	1,10E-04	1,79E-03	6,63E-06	-9,54E-04
ADPE	kgSb-Eq,	4,29E-05	5,22E-07	4,86E-06	9,65E-05	1,42E-06	2,88E-06	6,87E-09	-7,68E-07
ADPF	MJ	1,56E+02	3,76E+00	9,13E+00	3,38E+02	1,04E+01	1,03E+02	1,29E-01	-1,49E+02

GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources

	Unit	A1-A3	A4	A5	B4	C2	C3	C4	D
PERE	[MJ]	5,46E+00	4,68E-02	5,23E-01	1,21E+01	1,29E-01	2,48E+01	3,85E-03	-2,77E+00
PERM	[MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	[MJ]	5,46E+00	4,68E-02	5,23E-01	1,21E+01	1,29E-01	2,48E+01	3,85E-03	-2,77E+00
PENRE	[MJ]	1,76E+02	3,82E+00	1,00E+01	3,79E+02	1,06E+01	1,79E+02	1,34E-01	-1,81E+02

PENRM	[MJ]	3,63E+01	0,00E+00	4,35E+00	8,12E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	[MJ]	2,12E+02	3,82E+00	1,43E+01	4,61E+02	1,06E+01	1,79E+02	1,34E-01	-1,81E+02
SM	[kg]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,80E-01
FW	[m³]	2,70E-02	2,13E-04	2,31E-03	5,91E-02	5,87E-04	4,98E-02	1,65E-05	-1,00E-02
RSF	[MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	[MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water.

	Unit	A1-A3	A4	A5	B4	C2	C3	C4	D
HW	kg	2,38E-04	2,19E-06	1,68E-05	5,14E-04	6,04E-06	1,95E-04	9,79E-08	-8,00E-07
NHW	kg	4,69E-01	1,72E-01	1,31E-01	1,54E+00	4,66E-01	4,99E-01	4,88E-01	-2,29E-01
RW	kg	2,01E-04	2,45E-05	1,48E-05	4,81E-04	6,78E-05	1,18E-03	7,75E-07	-1,68E-06

HW = Hazardous waste; NHW = Non-hazardous waste; RW= Radioactive waste.

5. LCA: Interpretation

As shown in Figure 2, the life cycle impact of the Alkorplan F roofing sheet is dominated by the replacement phase (module B4). This was to be expected, since this phase represents the modules A1-A5 twice (2 replacements). Because the subsequent modules - i.e. C2, C3, C4 and D – account for 2 replacements, Figure 2 has to be put into perspective. To be able to compare the different phases over a similar timespan, the relative contribution of phases A1-A5 should be perceived as three times as big (or subsequent phases as three times as small).

The replacement stage determines between 42% (GWP), 60% (ADPE) and 54% (ODP) of the total life cycle impact. The replacement stage (B4), in turn, is determined for approximately 90% for all environmental indicators by the production phase (A1-A3). In the production phase, energy use contributes most to GWP (62%), followed by the GWP emissions associated with PVC (14%) and plasticisers (10%).

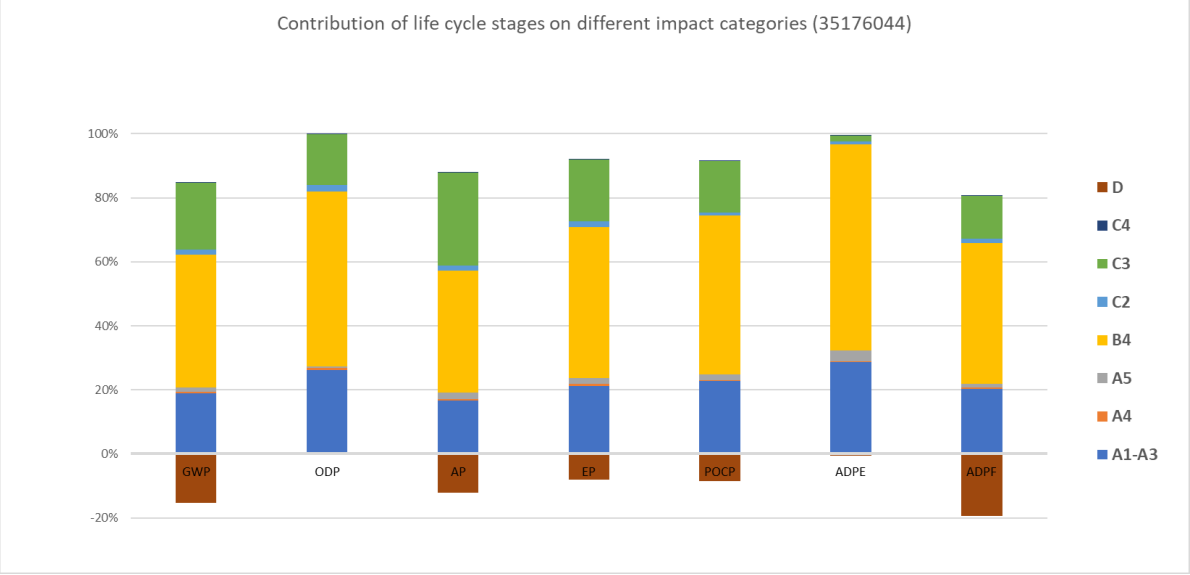

Figure 2: Contribution of the different life cycle stages to the environmental impact of one m² of Alkorplan F.

The figure additionally shows that many impact categories have a significant negative score (=impact benefits). This negative score is the result of avoided primary materials due to the 'Roofcollect recycling system'.

6. Programme-related information and verification

Product category rules (PCR):

- GENERAL PROGRAMME INSTRUCTIONS FOR THE INTERNATIONAL EPD® SYSTEM, 2015:11, version 2.5, International EPD® System
- CONSTRUCTION PRODUCTS AND CONSTRUCTION SERVICES, 2012:01, version 2.2, International EPD® System

Independent verification of the declaration and data, according to ISO 14025:2006:

☐ EPD Process Certification (internal) ☑ EPD Verification (external)

Third party verifier:'
Matthias Schulz, Schulz Sustainability Consulting, 70469 Stuttgart, Germany

Accredited by:
"Approved by the International EPD System"

7. Contact information

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8. References

[1] 'Environmental management - Life cycle assessment – Principles and Framework', International Organization for Standardization, ISO14040:2006.

[2] 'Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures', International Organization for Standardization, ISO14025:2006.

[3] 'Environmental management - Life cycle assessment - Requirements and guidelines', International Organization for Standardization, ISO14044:2006.

[4] '*GENERAL PROGRAMME INSTRUCTIONS FOR THE INTERNATIONAL EPD® SYSTEM*', 2015:11, version 2.5, International EPD® System

[5] 'Construction products and construction services', 2012:01, version 2.2, International EPD® System

[6] Flexible sheets for waterproofing – Plastic and rubber sheets for roof waterproofing – Definitions and characteristics', EN 13956:2012

[7] 'Flexible sheets for waterproofing – Reinforced bitumen sheets for roof waterproofing – Definitions and characteristics', EN 13707:2013

[8] 'Flexible sheets for waterproofing', 2015, Technical Committee CEN/TC 264