ENVIRONMENTAL PRODUCT DECLARATION

as per /ISO 14025/ and /EN 15804/

Owner of the Declaration	Vector Foiltec GmbH
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
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Issue date	15/01/2018
Valid to	14/01/2023

Texlon®-System with Fluon® ETFE FILM

Vector Foiltec GmbH

Asahi Glass Co., Ltd.

Institut Bauen und Umwelt e.V.

www.ibu-epd.com / https://epd-online.com

1. General Information

Vector Foiltec GmbH, Asahi Glass Co., Ltd.	Texlon® System with Fluon® ETFE FILM
Programme holder IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	**Owner of the Declaration** **Vector Foiltec GmbH** Steinacker 3 28717 Bremen GERMANY
Declaration number EPD-VFA-20170121-IBE1-EN	**Declared product / Declared unit** 1 m² of an average TEXLON® foil cushion incl. frame with of 4.56 kg/m² mass per unit area. (see 3.1 declared unit)
This Declaration is based on the Product Category Rules: ETFE construction element, 07.2014 (PCR tested and approved by the SVR) **Issue date** 15/01/2018 **Valid to** 14/01/2023	**Scope:** This EPD refers to individual building elements manufactured from ethylene tetrafluoroethylene (ETFE) and aluminium frame. It is valid for the German production facility. The building elements are manufactured by Vector Foiltec GmbH (Germany) with Fluon® ETFE FILM from Asahi Glass Co., Ltd. (AGC Asahi Glass) (Japan) and traded under the brand trade name Texlon®. The entire product chain associated with manufacturing of the ETFE building elements includes the following companies: - Asahi Glass Co., Ltd. (ETFE granulate and foil) - Vector Foiltec GmbH (ETFE foil cushions and building elements Texlon®) The Texlon® systems are designed, fabricated and packaged for specific projects. This EPD declares the life cycle analysis (LCA) for a representative product. The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.
Prof. Dr.-Ing. Horst J. Bossenmayer (President of Institut Bauen und Umwelt e.V.)	**Verification** The CEN Norm /EN 15804/ serves as the core PCR Independent verification of the declaration according to /ISO 14025/ ☐ internally ☒ externally
Dr. Burkhart Lehmann (Managing Director IBU)	Matthias Schulz (Independent verifier appointed by SVR)

2. Product

2.1 Product description / Product definition

The Texlon® System is based on the following principle: pneumatically stabilised foil elements are fixed to a sub-structure by means of a high-quality aluminium frame system. The system can consist of between two and five layers of ETFE foil (ethylene tetrafluoroethylene) depending on the building physics, static or design requirements and specifications. The g-values and U-values are determined by the number of layers and also the type of coating used. The ETFE foil thickness varies between 80 µm and 500 µm depending on the structural construction requirements. The individual layers are welded together at the edges and stabilised to approximately 220 Pa (220 N/m²) by means of a low-pressure air system.

The declared product in this EPD is an average system based on a typical 3-layer system with the following foil set up:

Outer: 200 µm // Middle: 100 µm // Inner: 200 µm

For use and application of the product, the respective national provisions at the place of use apply, in Germany for example the Building Codes of the countries and the corresponding national specifications.

2.2 Application

Texlon® systems are building elements used for cladding roofs and facades. The Texlon® system is suitable for new buildings and refurbishment projects looking to create additional spaces (such as courtyards). Well known examples of Texlon® include:

- Retail & Entertainment: The Avenues, Kuwait; Khan Shatyr Entertainment Center, Kazachstan
- Biospheres: Ecological Park, Heixidao, China
- Zoological Gardens: Zoo Emmen, the Netherlands; Arnhem Zoo Mangroove Hall, the Netherlands
- Stadia: National Swimming Center in Beijing, China; Olympic Stadium London, Refit, Great Britain; Baku Stadium, Azerbaijan; Forsyth Barr Stadium in Dunedin, New Zealand
- Airports: Gateway in Kuala Lumpur, Malaysia
- Exhibitions: Floating Pavilion in Rotterdam, the Netherlands
- Gallerias: Galleria Poznan, Poland
- Swimming Baths: Piscine in Champsaur, France
- Movable Roof: Sports Hub, Singapore
- Shopping Mall: Kocaeli Shopping Mall in Izmir, Turkey

2.3 Technical Data

The following technical data must indicate the relevant standard for the declared product at the time of delivery. Unless otherwise stated this data refers to an ETFE foil with a thickness of 200 µm.

Constructional data

Name	Value	Unit
Melting range /Melting point in accordance to /ASTM D 4591-07/	265±10	°C
Grammage	0.35	kg/m²
Tensile strength in accordance to /DIN EN ISO 527-3/	> 50	N/mm²
Tensile stress at 10% strain in accordance to /DIN EN ISO 527-3/	> 18	N/mm²
Tensile stress at break in accordance to /DIN EN ISO 527-3/	> 350	%
Tear Resistance in accordance to /DIN-EN-1875-3/	> 400	N/mm
Weld strength in accordance to /DIN 527-1/	≥ 33	N/mm²
Total energy transmittance in accordance to /ISO 15099/ 3 layers ETFE	75±5	%
Weathering resistance in accordance to /ISO 4892-1/ and /ISO 4892-2/ 3 layers ETFE	no optical or mechanical changes	-

Products for which no legal harmonization provisions of the EU exist: Performance data of the product with respect to its characteristics in accordance with the relevant technical provision (No CE-marking).

2.4 Delivery status

From an economic and technical perspective, the maximum ETFE cushion dimensions span ≤ 3.7 metres (width) by ≤ 40 metres (length). The cushion area should not exceed 120 m².

2.5 Base materials / Ancillary materials

The essential base products are Fluon® ETFE FILM, F16.2 aluminium frame and silicone gaskets.

Primary products	Mass-%
Aluminum frame	71,9%
ETFE film	19,2%
Silicone gasket	8,1%
PP Keder	0,8%
ETFE valves	< 0,05%
Total	100%

AGC Fluon® ETFE FILM: Fluon® ETFE FILM is a flexible and strong fluorinated copolymer foil. These foils are transparent over the entire solar range. They can be clear, printed or dyed.

ETFE valves: These valves are small parts made of the same base material as the foil but they are not transparent and display a lower purity level.

Aluminium frames: The aluminium frame comprises of an extruded base element and a cap.

Polypropylene (keder) ropes: The cord edge welding comprises of flexible polypropylene (keder) ropes with a diameter of ~ 8 mm.

Silicone seals: Silicone seals are made from a waterproof rubber silicone material.

None of the substances used for manufacturing of the Texlon® foil cushions are included in the SVHC list of candidates or in Annex XIV of the EU /REACH/ Directive 1907/2006. No fire retardants, plasticizers or biocides are used.

2.6 Manufacture

Manufacture of ETFE granulate:

Raw materials and monomers: R22 (Chlorodifluoromethane) is produced from fluorite and natural gas. The perfluorinated monomers such as TFE (Tetrafluoroethylene) is produced from R22 by pyrolysis process. The TFE monomer is distilled in order to obtain high purity for the polymerization process.

Polymerization: The TFE monomer is polymerized in the autoclave together with ethylene and additives and the ETFE polymer is produced. The residual monomers are recovered and reused for the polymerization.

Processing: The ETFE polymer is granulated and the ETFE beads are obtained. The beads are molten and pelletized with an extruder. The pellets are delivered to the customers and the film production process after quality check.

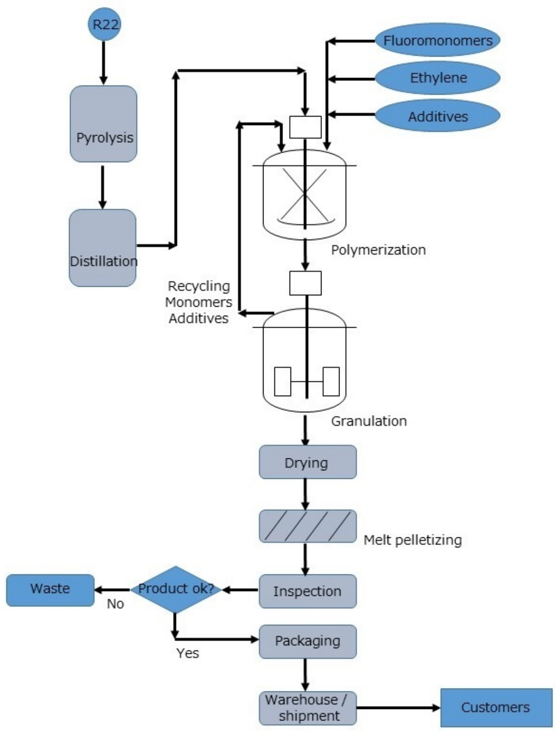


Figure : Flow chart of the ETFE production at AGC

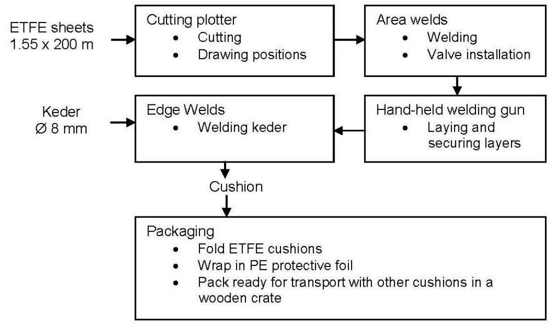
Production of AGC Fluon® ETFE FILM:

Fluon® ETFE FILM are manufactured by melt extrusion method.
Fluon® ETFE resin is fed into the extruder from the hopper.
The Fluon® ETFE resin is melted in the extruder and transferred to the die by the screw in the extruder.
Melted resin is extruded through the die onto the cooling roll and is formed into the foil.
The foil is carried on the rollers and the thickness or appearance of the foil are inspected by the inspection devices. After that, the edges of the foil are trimmed and finally the foil is rolled onto the core.

Fabrication of the foil cushions:

The foil rolls are produced in 1550 mm width and a length of between 100 to 500 metres, depending on the foil thickness. The rolls are cut in line with the project specifications. The individual cushion sections are cut to size on a plotter table, where also the position of other components like valves are drawn. In order to create larger areas, the individual sheets are welded together (area welding) and subsequently the valves are installed. The welded foil sheets are placed on top of each other in two or more layers and welded in place by means of a hand-held welding tongs. Edge welding involves welding a polypropylene keder rope along the perimeter of the foil package in order to seal the cushion and to make it airtight.

The large cushion is folded to form a sheet of approx. 30 cm in width and 2.5 metres in length and wrapped in a protective polyethylene foil. Between three to six cushions are placed in a wooden box in preparation for shipping. The other components of the Texlon® system (aluminium profiles, keder rails, gaskets, screws) are packaged separately for shipping.



2.7 Environment and health during manufacturing

Appropriate measures are taken in accordance with the current technology. To date, no environmental pollution as a direct result of the processing of the declared products is known.

The Texlon® quality management system at Vector Foiltec was implemented for internal monitoring. The QM system is based on /ISO 9001/ and the provisions of the general construction approval and/or the Building Regulation in individual cases. Over and above risk assessment and education for safety supervision by the body for social insurance against occupational accidents (SOZV), Vector Foiltec has commissioned an external consultant for training the employees on health and safety as well as on industrial protection measures.

Regarding the health and safety management during the manufacturing of the ETFE foil, AGC focuses on evaluating the volatile gases. AGC measures and controls the concentration of organic compounds at the workplace during the extrusion of fluoropolymers according to the Ordinance on Prevention of Organic Solvent Poisoning (The Ministry of Labour Ordinance No. 36, September 30, 1972).

The AGC Group is pushing ahead with health and safety activities by creating an occupational health and safety management system (OHSMS) in each business division, and regularly discusses at CSR Committee on its policies, measures and progress.

Also, the Group is urging each of its manufacturing plants to obtain certification from a third party OHSMS body, and, in addition, is taking steps to improve the management level of health and safety through internal audits conducted by the auditing division and each business division. Furthermore, the Group holds a Global Occupational Health and Safety Symposium on a regular basis with the participation of health and safety supervisors from various countries and regions, thereby disseminating best practices and deploying horizontal development at each manufacturing plant.

In 2013, in order to facilitate the integrated management of EHSQ (Environment, Occupational Health & Safety, and Quality) efforts across the Group as a whole, the AGC Group constructed and now operates the EHSQ Management System.

2.8 Product processing/Installation

Prior to installation of the roof areas, a risk assessment has to be performed in accordance with §5 of the German Occupational Safety Act (ArbSchG, §5):

a Environment-related risks

- Mechanical hazard
- Electrical hazard
- Hazardous substances
- Biological hazard
- Fire and explosion hazard
- Thermal hazard
- Hazards attributed to physical impact
- Hazard/Load due to working environment conditions
- Physical strain
- Other hazards/risks
- Psychological strain

b Planning the access equipment

c Site related inductions

In areas where there is a risk of falling, trained personnel are equipped with personal protective equipment (PPE) as well as working and safety ropes. In the event of tools or materials falling, the hazardous areas under the installation areas are secured.

2.9 Packaging

The packaging materials (wooden crates, polyethylene foil) are thermally recycled. The waste incurred can be allocated to the following waste codes /AVV/ 2012:

15 01 03: Wood
17 02 03: Plastic

2.10 Condition of use

No significant changes in the product characteristics are expected during its design life. To compensate for deviations in cushion pressure caused by changing external conditions (temperature, wind pressure loads/wind suction loads), the cushions are continuously supplied by one or more inflation units. The size of the roof determines the number and dimension of inflation units required. The units are controlled by a pressure sensor and internal pressure is maintained within a range between 180 Pa and 250 Pa. An average output of 60 W is required for a roof area of 1000 m². Under certain environmental climate conditions an air drier can be used.

2.11 Environment and health during use

In accordance with the evidence outlined in section 7, emissions to ambient air during the use phase are below the threshold values set by the /AgBB/ scheme.

2.12 Reference service life

Guaranteed service life is 25 years (up to 50 years are possible).

2.13 Extraordinary effects

Fire
Reaction to fire
In accordance with EN 13501 – 1, Fluon® ETFE FILM is specified as follows:

Fire safety

Name	Value
Building material class	B
Burning droplets	d0
Smoke gas development	s1

Water

ETFE foil is not effected by water. This is shown by a leaching test done in Norway /PD/CEN TS 16637 PD/CEN TS 16637-2/.

Mechanical destruction

The foils and cushions are extremely resistant to exterior pressure and tensile loads owing to their extraordinary elongation properties.

In the case of fire, explosions or even extreme hailstones, the system is extremely fault-tolerant and is resistant to consequential damage. The cushions can, however, be damaged by direct mechanical influences (or vandalism) with sharp or pointed items. Destruction of the exterior layer of foil does not lead to system failure. For example if the upper foil of a three-layer systems is damaged, a two-layer system is retained and the interior chamber remains protected from environmental influences. Minor damage can be easily repaired using Texlon® tape.

2.14 Re-use phase

As a general rule, the aluminium caps and base profiles of the Texlon® system can be re-used for new buildings and/or refurbishment projects. These components are usually recycled (statistic value for buildings: 85%).

Texlon® cushions that have reached the end of their useful phase as well as ETFE offcuts are recycled by external companies. ETFE valves and ETFE flexible pipes are produced from recycled ETFE foils. These parts are used for production of new Texlon® ETFE systems. Recycling is currently only carried out in Europe but will be extended to other regions in the near future. For the time being, waste in other countries is thermally recycled.

2.15 Disposal

The waste incurred can be allocated to the following waste codes:

17 02 03: Plastic
17 04 02: Aluminium

17 09 04: Mixed construction and demolition waste with the exception of waste covered by 17 09 01, 17 09 02 and 17 09 03

Silicone seals are thermally recycled but alternative recycling possibilities are currently being examined.

Polypropylene is recyclable but is usually thermally recycled.

2.16 Further information

Additional information is available on the Vector Foiltec homepage: www.vector-foiltec.com.

3. LCA: Calculation rules

3.1 Declared Unit

This declaration refers to the production of 1 m² of an average TEXLON® foil cushion incl. frame with a total mass of 4.56 kg/m² representing the average production of Vector Foiltec in 2015 converted into a 3-layer-system.

Declared unit

Name	Value	Unit
Declared unit	1	m^2
Conversion factor to 1 kg	0.219	-

3.2 System boundary

The EPD of the TEXLON® system, developed in this study, includes the production as well as installation, use stage and the End of Life of the product.
It represents a "cradle-to-gate" EPD with two options for foil cushion waste disposal at the end of life:

1. Waste incineration for ETFE foil and recycling of aluminium (EoL scenario 1)
2. Recycling of ETFE foil and aluminium (EoL scenario 2)

In both EoL scenarios the silicon seal is incinerated, while the aluminium frame is recycled.

The life cycle stages are as following:

- Production (A1 - A3): including the upstream chain associated with manufacturing of the preliminary products, transport thereof to the respective plant and loads from producing the granulate, foil and foil cushions including processing of production wastes
- Transport to the construction site (A4): average distances by truck, ship and/or plane
- Installation on the construction site (A5): energy for inflating foil cushions as well as disposal of packaging
- Energy consumption during use (B6): energy requirements for maintaining the interior cushion pressure
- Transport to disposal/recycling by truck (C2)
- Waste treatment for recycling (C3): processing foil waste for EoL scenario 2
- Disposal (C4): incineration of seals and for EoL scenario 1 incineration of foil cushions
- Benefits and loads beyond the product system boundary (D): Regarding scenario 1: the energy substitution for incineration of packaging waste, ETFE cushions incl. silicone seals, keder etc. and material recycling of aluminium profiles. Regarding scenario 2: the material recycling of aluminium profiles and ETFE foil plus energy benefit for plastic parts.

3.3 Estimates and assumptions

Estimates need to be made for the following cases:

- Printing of foil: The composition of the water-based varnish is estimated.
- Aluminium frame: Secondary material is considered in form of 45% secondary aluminium in the frame as conservative approach, due to the fact that exact information of the supplier is not available.
- ETFE material recycling (scenario 2): The recycled granulate cannot be used to produce foil cushions but is used to produce valves. This down-cycling is depicted via a correction factor for the material benefit based on current market prices.

3.4 Cut-off criteria

The cut-off criteria for including or excluding materials, energy and emissions data of the study are as follows:

Packaging waste (like foil, paper) of pre-products is not considered in this study due to negligible amounts (< 0.1%).
Besides the packaging waste within A1-A3 all available data from production processes are considered, i.e. all raw materials used, utilised thermal energy and electric power consumption as well as emissions and waste management processes using best available LCI datasets.

Thus, most materials and energy flows contributing less than 1% of mass or energy are considered.
Transport processes for the packaging materials are neglected.
Production of capital equipment, facilities and infrastructure required for manufacture are outside the scope of this assessment.

The sum of the excluded material flows does not exceed 5% of mass, energy or environmental relevance.

3.5 Background data

The /GaBi ts/ software was used to model the life cycle associated with Texlon® ETFE systems. The basic data in the GaBi database is applied for energy, transport, auxiliary products and preliminary products. It had been revised in 2016.

The headquarters of Vector Foiltec is in Germany, so the LCA for the TEXLON® element production is prepared under German boundary conditions. The ETFE foil production takes place in Japan and is considered as such. The electricity consumption for installation (A5) and utilization (B6) is related to Europe as an exemplified reference region.

3.6 Data quality

Overall the data quality can be described as good. The primary data collection has been done thoroughly, all relevant flows are considered.
To ensure consistency, all primary data are collected with the same level of detail, while all background data are sourced from the GaBi databases. Allocation and other methodological choices are made consistently throughout the model.

3.7 Period under review

Vector Foitec has provided production data based on the yearly average of 2015.
The printing process, raw material transport (beside ETFE foil; now Japan) and packaging material data have been collected in 2012 in the context of a former EPD study /Vector Foiltec EPD 2014/.

AGC has provided production data on yearly basis of 2014.

3.8 Allocation

The production process does not deliver any co-products. In this respect, the applied LCA model does not contain an allocation with the exception of a small amount of product waste that is recycled externally. Here a market allocation serves as calculation base for the potential benefits related to avoided burden of primary ETFE material.

Nevertheless, the overall Vector Foiltec production comprises further products beside the TEXLON construction elements with AGC Fluon® ETFE FILM (e.g. projects with other foil types and foil suppliers). Data for thermal and electrical energy as well as auxiliary material refer to the declared product. During data collection the allocation is done via mass.

A market price allocation serves as basis for the calculation of the potential avoided burden for virgin ETFE foil production in case of material recycling in End of Life (scenario 2).

3.9 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. GaBi ts serves as background database for the calculation /GaBi ts/ .

4. LCA: Scenarios and additional technical information

The following information forms the basis for the declared modules. It can be used to develop specific scenarios in the context of a building evaluation if modules are not declared (MND).

Transport to site (A4)

Average distance per mode of transport refers to global international transport data (2012).

Name	Value	Unit
Litres of fuel truck	0.00156	l/100km
Transport distance truck	1779	km
Capacity utilisation (including empty runs) truck	70	%
Litres of heavy fuel oil ship	0.00147	l/100 km
Ship transport distance ship	14123	km
Ship capacity utilisation (incl. empty runs) ship	48	%
Litres of kerosene airplane	0.0190	l/100 km
Air transport distance airplane	10221	km
Air capacity utilisation (incl. empty runs) airplane	66	%

Installation Process (A5)

Name	Value	Unit
Auxiliary	0	kg
Water consumption	0	m^3
Other resources	0	kg
Electricity consumption per a*m²	0.00018	kWh
Other energy carriers	0	MJ
Material loss	0	kg
Output substances following waste treatment on site	0	kg
Dust in the air	0	kg
VOC in the air	0	kg

The amount of installation waste varies and is not declared within this EPD. For calculation of the environmental impact of the ETFE construction element including a certain amount of installation waste the values for the production stage (A1-A3) and end of life (C3, C4 and D) have to be multiplied with the amount of waste (e.g. 2% installation waste, factor 1.02)

Reference service life

Name	Value	Unit
Life Span according to BBSR	-	a
Life Span according to the manufacturer	25 - 50	a

Guaranteed service life is 25 years.

Operational energy (B6)

Name	Value	Unit
Electricity consumption per a*m²	0.274	kWh

End of Life (C1-C4)

Conservative estimate for transport to EoL (scenario 2): 1,000 km for transport in Europe (material recycling is currently only performed in Europe). Shorter transport distance for EoL scenario 1.

Name	Value	Unit
Collected separately (total product)	4.56	kg
Collected as mixed construction waste	0	kg
Reuse	0	kg
Recycling Scenario 1+2: Aluminium	3.27	kg
Energy recovery: Scenario 1+2: Seals	0.37	kg
Recycling: Scenario 2: foil cushions	0.914	kg
Energy recovery: Scenario 1: foil cushions	0.914	kg
Landfilling	0	kg

Re-use, recovery and recycling potential (D), relevant scenario information

Module D includes benefits from energy substitutions from incineration processes of packaging waste (A5), seals, and the foil cushions in scenario 2 (C4) and from recycling the aluminum frames as well as foil cushions in scenario 1. A waste incineration plant with an R1 value of < 0.6 is assumed.

In case of material recycling the avoided burden to produce virgin material is considered as benefit (EoL scenario 2).

5. LCA: Results

The following table depicts the results of the indicators concerning the estimated impact, use of resources as well as waste and other output flows in relation to 1 m² of Texlon® system.
C2/1, C3/1, C4/1 and D/1 refer to incineration of ETFE.
C2/2, C3/2, C4/2 and D/2 refer to material recycling of ETFE.
The aluminium frame is recycled in both scenarios. The silicon sealing is assumed to be incinerated.

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 from the gate to the site	Assembly	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	MNR	MNR	MNR	X	MND	MND	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 m² Texlon-System

Parameter	Unit	A1-A3	A4	A5	B6	C2/1	C2/2	C3/1	C3/2	C4/1	C4/2	D/1	D/2
GWP	[kg CO_2-Eq.]	58.20	1.11	0.58	0.12	0.06	0.11	0.00	0.58	1.65	0.38	-14.50	-32.81
ODP	[kg CFC11-Eq.]	2.30E-4	6.07E-14	2.05E-14	5.40E-12	1.99E-14	3.64E-14	0.00E+0	2.11E-12	5.61E-13	1.37E-13	-5.44E-11	-1.30E-4
AP	[kg SO_2-Eq.]	1.43E-1	3.43E-3	4.95E-5	3.48E-4	1.40E-4	2.57E-4	0.00E+0	8.64E-4	1.84E-2	5.23E-4	-7.36E-2	-9.39E-2
EP	[kg $(PO_4)^{3-}$-Eq.]	1.02E-2	7.01E-4	1.08E-5	3.15E-5	3.35E-5	6.13E-5	0.00E+0	1.71E-4	6.55E-5	3.21E-5	-4.25E-3	-5.66E-3
POCP	[kg ethene-Eq.]	1.24E-2	2.26E-4	4.27E-6	2.22E-5	-4.52E-5	-8.27E-5	0.00E+0	5.94E-5	2.81E-5	9.69E-6	-4.03E-3	-6.47E-3
ADPE	[kg Sb-Eq.]	1.42E-4	4.22E-8	6.35E-9	4.86E-8	4.77E-9	8.72E-9	0.00E+0	2.81E-7	2.23E-7	2.03E-8	-7.12E-6	-2.12E-5
ADPF	[MJ]	563.00	15.40	0.10	1.30	0.82	1.50	0.00	5.48	0.72	0.19	-159.00	-287.00

Caption	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

RESULTS OF THE LCA - RESOURCE USE: 1 m² Texlon-System

Parameter	Unit	A1-A3	A4	A5	B6	C2/1	C2/2	C3/1	C3/2	C4/1	C4/2	D/1	D/2
PERE	[MJ]	131.00	0.10	2.91	0.73	0.04	0.08	0.00	3.07	0.16	0.03	-81.50	-84.30
PERM	[MJ]	2.89	0.00	-2.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERT	[MJ]	134.00	0.10	0.02	0.73	0.04	0.08	0.00	3.07	0.16	0.03	-81.50	-84.30
PENRE	[MJ]	593.00	15.40	1.85	2.13	0.82	1.50	0.00	7.12	20.26	5.52	-191.00	-317.00
PENRM	[MJ]	21.15	0.00	-1.74	0.00	0.00	0.00	0.00	-14.11	-19.41	-5.30	0.00	0.00
PENRT	[MJ]	613.00	15.40	0.11	2.13	0.82	1.50	0.00	-6.99	0.85	0.22	-191.00	-317.00
SM	[kg]	1.48E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.79E+0	2.69E+0
RSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
NRSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
FW	[m³]	3.59E-1	1.32E-4	1.35E-3	1.04E-3	7.64E-5	1.40E-4	0.00E+0	2.29E-3	5.12E-3	1.42E-3	-2.10E-1	-2.55E-1

Caption	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

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 m² Texlon-System

Parameter	Unit	A1-A3	A4	A5	B6	C2/1	C2/2	C3/1	C3/2	C4/1	C4/2	D/1	D/2
HWD	[kg]	4.26E-3	5.96E-8	9.07E-11	8.64E-10	4.32E-8	7.90E-8	0.00E+0	4.83E-9	3.95E-8	1.50E-9	4.88E-3	4.87E-3
NHWD	[kg]	5.46E+0	1.67E-4	1.05E-3	1.40E-3	6.28E-5	1.15E-4	0.00E+0	1.39E-2	3.27E-1	4.94E-2	-3.83E+0	-3.89E+0
RWD	[kg]	2.30E-2	1.15E-5	4.56E-6	3.32E-4	1.12E-6	2.05E-6	0.00E+0	6.54E-4	4.95E-5	1.11E-5	-1.23E-2	-1.35E-2
CRU	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MFR	[kg]	0.00	0.00	0.00	0.00	3.27	3.27	0.00	0.90	0.00	0.00	0.00	0.00
MER	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	[MJ]	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.00	1.72	0.90	0.00	0.00
EET	[MJ]	0.00	0.00	1.95	0.00	0.00	0.00	0.00	0.00	4.09	0.35	0.00	0.00

Caption	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EEE = Exported thermal energy

Note: The values in module B6 refer to a period of use of one year. When using the values in the building, they must be scaled to the building service life time.

6. LCA: Interpretation

Production (A1-A3)
The manufacturing of main materials cushion and aluminium frame are most important for the environmental profile of the TEXLON® system. The main influence of the cushion is visible in the categories global warming (**GWP**), ozone depletion (**ODP**), fossil resource depletion (**ADPf**) and primary energy consumption (**PENRT**). Relevant influence is visible in all other categories.
Aluminium frame is of significant influence in acidification (**AP**), eutrophication (EP) and abiotic resource depletion (**ADPe**) and of relevant influence in most of the considered impact categories (**GWP, POCP, ADPF** and **PENRT**). Minor or even negligible influence is given with regard to **ODP**.
All other processes and materials are of minor importance and show impact shares < 10% with the exception of -14% ODP-result during TEXLON production, which is caused by benefits related to ETFE recycling. Worth mentioning is cleaning of printed areas prior to welding of the ETFE foil by means of bio-ethanol, which causes a minor effect on **POCP**. Transport has some importance regarding **EP** and **AP**. The loads from energy consumption are of minor importance in **GWP** and the energy related categories **ADPf** and **PENRT**.

Whole life cycle
The main contributors - valid for all impact categories considered - are the preliminary processes (pre-chain) in A1 to 3, most notably the manufacturing of the cushion and aluminum profiles. Neither transport to site, energy consumption during installation, nor transport to disposal are of mentionable relevance.
It must be noted that the use stage impact (B6) relate to the effort per year. Assuming a service life of 25 years the impact of B6 would increase to 5 to 9% relating to the manufacturing impact (A1-A3). Potential benefits by means of energy and materials in module D do provide significant influence. Two scenarios are presented for the End of Life:

1. Energy recovery of the cushion
2. Material recycling of the cushion

The aluminium frame is recycled in both cases. Benefits are incurred for both scenarios but are higher for material recycling.

7. Requisite evidence

7.1 VOC emissions
Inspection of the AGC Fluon® ETFE FILM for VOC emissions in accordance with the AgBB scheme /AgBB 2015/ was carried out in September 2017 by the Environmental Institute Bremen (Bremer Umweltinstitut – Gesellschaft für Schadstoffanalysen und Begutachtung mbH).

Measurement conditions:
- Temperature: 23°C
- Area specific air flow rate: 0.36 m³/(m²h)
- Loading: 1.4 m²/m³

AgBB Results (28 days)

Name	Value	Unit
TVOC (C6 - C16)	18	µg/m³
Sum SVOC (C16 - C22)	< 1	µg/m³
R (dimensionless)	0.016	-
VOC without NIK	< 5	µg/m³
Carcinogenic Substances	< 1	µg/m³

Detection limit: 1 µg/m³

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