ENVIRONMENTAL PRODUCT DECLARATION

as per ISO 14025 and EN 15804

Owner of the Declaration	Vector Foiltec GmbH;
	Nowofol Kunststoffprodukte GmbH;
	Dyneon GmbH
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
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Valid to	05.05.2020

Texlon®-System

Vector Foiltec GmbH Nowofol Kunststoffprodukte GmbH & Co. KG Dyneon GmbH



www.bau-umwelt.com / https://epd-online.com



1. General Information

Vector Foiltec GmbH Nowofol Kunststoffprodukte GmbH & Co. KG Dyneon GmbH

Programme holder

IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany

Declaration number EPD-DVN-20140043-IBE1-EN

This Declaration is based on the Product Category Rules:

ETFE construction element, 07.2014 (PCR tested and approved by the SVR)

Issue date

06.05.2014

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Texlon[®] System

Owner of the Declaration

Vector Foiltec GmbH, Steinacker 3, 28717 Bremen Nowofol Kunststoffprodukte GmbH & Co. KG, Breslauer Str. 15, 83313 Siegsdorf Dyneon GmbH, Industrieparkstr. 1, 84508 Burgkirchen

Declared product / Declared unit

1 m² of standard foil cushion (weight per unit area 0.896 kg/m²) and the associated frame materials

Scope:

This EPD refers to individual building elements manufactured from ethylene tetrafluoroethylene (ETFE). It is valid for the German production facilities. The building elements are manufactured by Vector Foiltec GmbH and traded under the brand trade name Texlon®. The entire product chain associated with manufacturing of the ETFE building elements includes the following companies:

- Dyneon GmbH (ETFE granulate)

- NOWOFOL Kunststoffprodukte GmbH & Co.
- KG (ETFE foil)

- Vector Foiltec GmbH (ETFE foil cushions)

Foil cushions are designed, fabricated and packaged for specific projects. This EPD calculates the life cycle analysis (LCA) for a representative product.

This document is translated from the German Environmental Product Declaration into English. It is based on the German original version EPD-DVN-20140043-IBE1-DE. The verifier has no influence on the quality of the translation. 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.

Verification

The CEN Norm /EN 15804/ serves as the core PCR Independent verification of the declaration

according to /ISO 14025/

internally x externally

Matthias Schulz (Independent verifier appointed by SVR)

Wrennages

Prof. Dr.-Ing. Horst J. Bossenmayer (President of Institut Bauen und Umwelt e.V.)

Mann

Dr. Burkhart Lehmann (Managing Director IBU)

2. Product

2.1 Product description

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 vary between 80 μ m and 300 μ m depending on the static 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.

This EPD is based on a typical 3-layer system with the following build up:

Upper: 200 µm // Middle: 100 µm // Lower: 200 µm

The LCA for a representative product is calculated in this EPD.

2.2 Application

Texlon® systems are building elements used for the cladding of 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:

- Leisure centres: Center Parcs in Moselle, France
- <u>Retail & entertainment</u>: Khan Shatyr Entertainment Centre in Astana, Kazakhstan
- <u>Artifical biospheres</u>: Eden Project in Cornwall, Great Britain
- <u>Zoological gardens</u>: Gondwanaland Tropical Hall Leipzig, Germany
- <u>Atria</u>: Frankfurt Holm, Germany
- <u>Canopies</u>: Domaquaree in Berlin, Germany
- <u>Stadia</u>: Forsyth Barr Stadium in Dunedin, New Zealand
- Airports: Baufeld H in Frankfurt, Germany
- <u>Hospitals</u>: Chelsea & Westminster Hospital in London, Great Britain
- <u>Kindergardens</u>: Plappersnut in Wismar, Germany
- <u>Schools</u>: Neues Gymnasium in Bochum, Germany
- Office buildings: Festo in Esslingen, Germany
- <u>Exhibitions</u>: Mobile Chanel Pavillon in Paris, France

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 μ m.

Constructional data

Name	Value	Unit
Melting range /Melting point in accordance to /ASTM D 4591-07/	265±10	°C
Grammage	0.35	kg/m ²
Tensile strength in accordance to	> 40	N/mm ²

/DIN EN ISO 527-1/		
Tensile stress at 10% strain in accordance to /DIN EN ISO 527- 1/	> 18	N/mm ²
Tensile stress at break in accordance to /DIN EN ISO 527- 1/	> 300	%
Tear Resistance in accordance to /DIN 53363/	> 300	N/mm
Weld strength in accordance to /DIN 527-1/	≥ 33	N/mm ²
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 mechanica I changes	-

2.4 Placing on the market / Application rules

In Germany, Texlon® foil cushions are regarded as non-regulated building products in terms of the state building regulations and as such require fit for purpose proof in the form of a general construction approval by the Deutsches Institut für Bautechnik Berlin or appropriate authorisation by the responsible Department of Building Regulation in individual cases.

2.5 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 m^2 .

2.6 Base materials / Ancillary materials

The essential base products are Nowoflon® ET foil, F16.2 aluminium frame and sealing materials.

Primary products	Mass percentage rate	
Nowoflon - ETFE foil	12.0-24.5	
ETFE valves	0.03-0.04	
aluminium frame	66.7-78.1	
PP keder	0.31-0.37	
silicone gasket	3.48-9.54	

Nowoflon® ET foil: Nowoflon® ET foil is a flexible and strong fluorinated copolymer foil. These foils are transparent over the entire solar range. They can be transparent, 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.



No substances used in the manufacture of TexIon® 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 biocidals are used.

2.7 Manufacture

Manufacture of ETFE granulate:

Raw materials and monomers: Mineral fluorspar and natural gas are used to manufacture R22 (chlorine-di-fluoromethane), which is delivered by special road tankers. This is used to manufacture the perfluorinated monomers, such as tetrafluoroethylene (TFE), hexafluoropropylene (HFP) and perfluoro (propyl vinyl ether), by thermal conversion, which are in turn freed of ancillary products by means of distillation.

Polymerisation: These monomers together with ethene are converted to a thermoplastic dispersion by means of emulsion polymerisation. Non-converted monomers and polymerisation auxiliaries such as emulsifiers are returned to the monomer plant after distillation and reused.

Recycling (Reprocessing): The degassed thermoplastic dispersion is precipitated and the ensuing powder is dried. Floatation and the low pourability of this powder mean it is difficult to process so it is melted to granulate prior to shipping. The granulate is subjected to quality control to determine whether the product complies with customer requirements.



Production of Nowoflon® ET foils:

ETFE foils are manufactured by cast film extrusion where the granulate is fed into the extruder via a funnel. The granulate is melted in the extruder where it is also homogenised. A downstream extrusion tool, fishtail nozzle, extrudes the melted plastic onto a chill roller from which it is peeled off. The next stage involves an inline inspection of the foil thickness and trimming of the foil edges. These trimmings are immediately ground down and redirected to the extrusion process by means of the funnel. The last step of the foil extrusion process involves winding the foil onto a cardboard roll.

Foil waste that cannot be directly recycled passes through a second stage on a regeneration machine before being processed into foil, the application of the recycled material is always subject to a so-called "down-cycling" process.

Fabrication of the foil cushions:

The foil rolls are produced in 1550 mm (width) and – depending on the foil thickness – a length of approximately 200 metres. The rolls are cut in line with the project specifications. The individual cushion sections are cut to size on a cutting plotter. The positions of other components such as valves are also 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 a polypropylene (keder) rope being welded along the edges of the cushions in order to seal the cushions.

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



2.8 Environment and health during manufacturing

The 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 was implemented with the purpose of 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. In addition to safety supervision education and risk assessment by the body for social insurance against occupational accidents (SOZV), Vector Foiltec commissions an external consultant to educate employees on health and safety and industrial protection issues.

At Nowofol, the primary health and safety focus during the manufacture of fluoropolymer foil is on evaluating gases and vapours. In 2011, TÜV SÜD was appointed to determine the concentration of smoke, fluorides and fluorocarbons as well as volatile organic compounds in air at the workplace during the extrusion of fluoropolymers in line with the occupational exposure limits according to TRGS 900. This exposure assessment found that the existing protective measures (extraction for the purpose of air purification) are sufficient.

Within the framework of the Occupational Health and Risk Management System (Ohris), Dyneon is certified under register number 09-00015 (OHRIS 2009).

2.9 Product processing/Installation

Prior to installation of the roof areas, a risk assessment must be drawn up 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.

2.10 Packaging

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

- 15 01 06: Mixed packaging
- 15 01 03: Wood
- 15 01 01: Paper and cardboard
- 17 09 04: Mixed construction & demolition waste excluding waste covered by 17 09 01 to 17 09 03 20 03 01: Mixed municipal waste

2.11 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 of inflation units required. The units are controlled by a pressure sensor and internal pressure is maintained within 180 Pa and 250 Pa range. An average output of 60 W is required for a roof area of 1000 m². If required an air drier can be used in certain air/humidity conditions.

2.12 Environment and health during use

In accordance with the evidence outlined in section 7, the emissions to air during the use phase fall below of the limit values as per the AgBB scheme.

2.13 Reference service life

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

2.14 Extraordinary effects

Fire

Reaction to fire

In accordance with EN 13501 - 1, Nowoflon® ET foil is specified as follows:

Fire safety

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

Water

Nowoflon® ET foil is not effected by water.

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 threelayer 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.

2.15 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 and ETFE offcuts are recycled by external companies into valves and other small parts that can be used for manufacture of new ETFE systems. Recycling is currently only carried out in Europe but will be extended to other regions in future. Waste is thermally recycled in other countries.

2.16 Disposal

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

17 02 03: Plastic

3. LCA: Calculation rules

3.1 Declared Unit

This declaration refers to the production of 1 m² of a representative foil cushion (average values from 2012).

Declared unit

Name	Value	Unit
Declared unit	1	m²
Conversion factor to 1 kg	0.195	-

3.2 System boundary

In addition to production, this LCA considers installation, energy consumption during use and disposal. It represents a cradle-to-plant gate scenario with two options for foil cushion waste disposal:

- 1. Waste incineration
- 2. Recycling

Waste processing is considered for scenario 2. In both cases, the seal is incinerated while the aluminium frame is recycled. The life cycle stages are explained in detail below:

- Production (A1 A3) including the upstream chain associated with manufacturing of the preliminary products, transport thereof to the respective plant and expenses involved in producing granulate, foil and foil cushions
- Transport to the construction site (A4): average distances by truck, ship and/or air
- 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 (C2)
- Waste treatment for recycling (C3): processing foil waste for scenario 2
- Disposal (C4): incineration of seals and for scenario 1 incineration of foil cushions
- Credits (D): from energy for treatment of packaging waste (A5) and the silicone seals, recycling of aluminium profiles and expenses associated with processing (remelting) and the energy credit in scenario 2 for thermal recycling of the ETFE granulate

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.

2.17 Further information

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

3.3 Estimates and assumptions

Estimates need to be made for the following cases:

- ETFE production: Characterisation factors for the Global Warming Potential for the organic HFP and TFE emissions are applied from a publication (ACERBONI ET AL. 2001) as no information is available yet from CML (CML 2010) (HFP: 0.25 kg CO2 equiv.; TFE: 0.021 kg CO2 equiv.).
- Dyeing the granulate: "Compound" and "Masterbatch" pigments are estimated.
- Printing of foil: The composition of the waterbased varnish is estimated.
- Aluminium frame: No manufacturer information is available. According to a certificate, some post-consumer secondary material is available which is used.
- 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 credit based on current market prices.
- Processing sulphuric acid in the manufacture of ETFE granulate.

3.4 Cut-off criteria

All data from operational data collation at Vector Foiltec, Nowofol and Dyneon has been taken into consideration, i.e. all base materials used in accordance with the recipe formula. Transport is recorded for all essential preliminary products, transporting the products to the site and in the End-of-Life scenario.

The LCA considers production waste incurred directly during production as well as the associated electrical and thermal energy and packaging materials.

Machinery, plant and infrastructure as well as the transport of packaging materials required for the manufacturing process are ignored.



Material mass and energy flows less than 1 per cent are also considered.

3.5 Background data

The GaBi 6 software was used to model the life cycle associated with Texlon® ETFE systems. The basic data in the GaBi databank is applied for energy, transport, auxiliary products and preliminary products.

The headquarters of the respective companies are in Germany, so the LCA is prepared with Germany as the reference country. Transport to construction sites is modelled internationally. The power consumption for installation and utilization phases relate to Europe and can be adapted for other countries as required.

3.6 Data quality

The data was collated by the three companies on the manufacure of foil cushions, foil and granulate. Information was obtained from external manufacturers to prepare estimates concerning the dyeing and printing processes. The background data was revised in 2013. The data quality is classified as very good as the primary data was collated for manufacturing of the foil cushions as well as the foil and granulate.

3.7 Period under review

The data for this Life Cycle Assessment is based on records from 2012 for each company. The volumes of raw materials, energy, auxiliary materials used are considered as average annual values in the respective plant.

3.8 Allocation

Economic allocations based on the market price for the ancillary products are used for the manufacture of chlorine-di-fluoromethane, perfluoropropyl vinyl ether as well as production of the ETFE granulate base.

Economic allocation is not applied to waste production at Vector Foiltec as it only makes a minor contribution (< 1%) to turnover. Aluminium profiles with a postconsumer recycling share of 45% (in accordance with supplier's certificate), are modelled as scrap input (open-loop recycling).

For incineration processes the credits for electrical and thermal energy are evaluated by taking the elementary composition and calorific value into account.

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.

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 refer to global international transport data (2012).

Name	Value	Unit
Litres of fuel truck	0.00156	l/100km
Transport distance truck	1026	km
Capacity utilisation (including empty runs) truck	85	%
Capacity utilisation volume factor container	0.5	-
Litres of ship fuel ship	0.00147	l/100 km
Ship transport distance ship	16291	km
Ship capacity utilisation (incl. empty runs) ship	65	%
Litres of air fuel airplane	0.0190	l/100 km
Air transport distance airplane	10683	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 pro a*m ²	0.00018	kWh
Other energy carriers	0	MJ
Material loss	0	kg
Output substances following	0	kg

waste treatment on site		
Dust in the air	0	kg
VOC in the air	0	kg

Reference service life

Guaranteed service life is 25 years (50 years possible).

Name	Value	Unit
Reference service life	25 - 50	а

Operational energy (B6) and water (B7)

Name	Value	Unit
Water consumption	0	m ³
Electricity consumption pro a*m ²	0.274	kWh
Other energy carriers	0	MJ
Equipment output	0	kW

End of Life (C1-C4)

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

Name	Value	Unit
Collected separately (total	5 13	ka
product)	0.15	кy
Collected as mixed construction	0	ka
waste	0	ĸġ
Reuse	0	kg
Recycling aluminium profile	4.02	kg
Thermal recycling Seals	0.212	kg
Recycling: Scenario 1, foil	0.896	kg

cushions		
Thermal recycling: Scenario 2, foil cushions	0.896	kg
Landfilling	0	kg

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

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

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.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)																	
PRODUCT STAGE CONSTRUCTI ON PROCESS STAGE				USE STAGE						END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM			
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement ¹⁾	Refurbishment ¹⁾	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Recovery- Recycling- potential	
A1	A2	A3	A4	A5	B1	B2	B3	B4	4 B5	B6	B7	C1	C2	C3	C4		D
Х	Х	Х	X	Х	MND	MND	MNR	MN	R MNR	X	MND	MND	X	X	Х		Х
RESL	JLTS	OF TH	IE LCA	- EN\	/IRO	MENT	AL IM	PAC	CT: 1 m	² Texloi	n®-Sy	stem		1	T		
Param eter	U	nit	A1-A3	4	4	A5	B6		C2	C3/1	C3	2	C4/1	C4/2	D	/1	D/2
GWP ODP AP EP POCP	[kg CC [kg CFC [kg SC [kg (PC [kg ethe	D ₂ -Eq.] C11-Eq.] D ₂ -Eq.] D ₄) ³ -Eq.] ene-Eq.]	4.07E+ 1.85E-6 1.73E-1 1.02E-2 1.26E-2	1 1.83 5 1.18 5.55 2 1.10 2 4.9	3E+1 E-10 5E-2 DE-2 DE-3	5.75E-1 3.57E-12 5.21E-5 1.08E-5 5.09E-6	1.32E 1.18E- 6.25E 3.29E 3.68E	-1 -10 -4 -5 -5	1.05E-1 1.84E-12 2.75E-4 5.70E-5 -6.99E-5	5.75E-1 3.22E-10 1.03E-3 1.44E-4 7.49E-5	0.008 0.008 0.008 0.008 0.008	+0 2 +0 2 +0 5 +0 5 +0 5	2.52E-1 2.67E-11 5.02E-4 2.34E-5 2.03E-5	1.50E+0 4.28E-1 1.81E-2 5.62E-5 4.23E-5) -2.46 1 -8.7 -1.2 -6.3	6E+1 9E-7 6E-1 0E-3 8E-3	-1.97E+1 -5.86E-9 -1.09E-1 -4.99E-3 -5.95E-3
ADPE	[Kg S [N	<u>b-Eq.j</u> 1J]	9.54E-5	2 2.56	1E-7)E+2	5.18E-9 1.00E-1	1.82E	<u>-8</u> +0	3.92E-9 1.45E+0	9.54E-8 5.71E+0	0.00	<u>+0</u> E+0 (1.88E-8 6.31E-1	2.11E-7 1.18E+0	-2.5	2E-5 1E+2	-8.21E-6 -1.94E+2
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																	
RESL	JLTS	OF TH	IE LCA	- RE	SOUR	CE US	E: 1 m	² Te	exlon®-	System							
Param	eter l	Jnit	A1-A3	A4		A5	B6		C2	C3/1	C3/2	2	C4/1	C4/2	D	/1	D/2
PER	E [MJ]	1.25E+2					_			0.00E	+0			IN	D	
PER	T [MJ]	1.25E+2	5.57E	-1 1	.05E-2	3.88E-1	Į	5.70E-2	1.54E+0	0.00L	+0 3	.26E-2	1.02E-1	-9.07	E+1	-8.36E+1
PENF	RE [MJ]	5.73E+2			IND	IND		IND	IND	0.00E	+0	IND	IND	IN	D	IND
PENE	avi j RT I	MJI	1.60E+1 5.89E+2	2.56E	+2 1	16F-1	2.33E+0	$\frac{1}{1}$	145E+0	7.93E+0	0.00E	+0 6	IND 84F-1	1.34E+0	-3.33	D F+2	-2 46E+2
SM		[kg]	1.82E+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	IN	D	IND
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	0.00	E+0	0.00E+0
FW		ivij [m³]	0.00E+0 3.52E-1	0.00E	-3 1	.00E+0 .35E-3	1.04E-3		6.33E-5	2.47E-3	0.00E	+0 0 +0 9	.00E+0	4.50E-3	-2.57	E+0 /E-1	-2.22E-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; PERM = Use of non-renewable primary energy resources used as raw materials; PERM = Use of non-renewable primary energy resources used as raw materials; PENRE = Use of non-renewable primary energy resources; SM = Use of non-renewable primary energy resources; SM = Use of non-renewable primary energy resources; SM = Use of net fresh water																	
RESU 1 m² [·]	JLTS Texlo	OF TH n®-Sv	IE LCA /stem	– OU	TPUT	FLOW	/S ANI	D W	ASTE (CATEG	ORIES						
Param	eter l	Jnit	A1-A3	A4		A5	B6		C2	C3/1	C3/2	2	C4/1	C4/2	D	/1	D/2
HW)	[kg]	5.67E-2	0.00E	+0 9	.85E-4	0.00E+0		0.00E+0	2.30E-3	0.00E	+0 8	.99E-3	9.02E-3	-1.47	7E-2	3.01E-3
NHW	D	[kg]	4.51E+0	1.86E	-3 5	5.18E-5	1.01E-3	3	1.89E-4	9.07E-3	0.00E	+0 1	.93E-2	2.91E-1	-3.06	E+0	-2.97E+0
	וו	[kg] [ka]	4.07E-2 0.00E+0	2.48E 0.00F		.40E-6	0.00E+0		2.02E-6	9.17E-4 0.00E+0	0.00E	+0 2 +0 0	10E-5 .00E+0	0.00E+0	-2.54	+⊏-2 D	-2.14E-2
MFF	2	[kg]	0.00E+0	0.00E	+0 0	.00E+0	0.00E+0) 4	4.02E+0	8.78E-1	0.00E	+0 0	.00E+0	0.00E+0	IN	D	IND
MEF	2	[kg]	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	IN	D	IND
		MJI	0.00E+0	0.00E	+0 7 +0 1	.99E-1	0.00E+0		0.00E+0	0.00E+0	0.00E	+0 2 +0 7		1.74E+0 4.95E+0	IN IN	ם	
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's total useful life.

Note on caption: The first reference to EEE (Exported Electrical Energy) is correct. The second reference EEE should read either ETE (Exported Thermal Energy) or EET (Exported Energy Thermal).

6. LCA: Interpretation

The majority of environmental impacts and the use of primary energy are caused by the upstream chain, i.e. manufacture of the preliminary products, whereby a large percentage is credited again during recycling. Manufacture of the aluminium frame in particular represents a significant percentage of the overall mass and is clearly apparent during the production phase. The actual foil cushion also contributes a significant impact on the life cycle. This is particularly attributable to the production of granulate. Production at Vector Foiltec has barely any effect on the impact categories under review (up to max. 6% of the overall production phase).

The other impact categories essentially follow this breakdown for the entire production phase too. Transport to the construction site is modelled in accordance to the international distribution of the Texlon® system and is based on average values for 2012. Since some of the distances are long, the effects are apparent; in the case of the Eutrification Potential, they even exceed those for production of the declared product on account of emissions incurred by such transport. But transport can also be significantly less intensive for specific projects.

Neither the energy required for initial inflation of the foil cushion (Module A5) nor for maintaining the internal cushion pressure during the utilization phase (Module B6) contribute significantly to the overall life cycle in any of the impact categories. It must be noted that these values relate to a life cycle of one year and need to be adapted to the requisite service life of a building LCA. For calculations extending over 25 years, the contribution is less than 15% in relation to the entire life cycle of the foil cushion. Two scenarios are presented for the End of Life:

1. Material recycling of the foil cushion

2. Thermal recycling of the foil cushion

In both cases the aluminium frame is recycled. Credits are incurred for both scenarios but are higher for material recycling.

7. Requisite evidence

7.1 VOC emissions

Inspection of the Nowoflon® ET foil for VOC emissions in accordance with the AgBB scheme (AgBB 2010) was carried out in December 2009 by the Bremer Umweltinstitut – Gesellschaft für Schadstoffanalysen und Begutachtung mbH.

Measurement conditions:
Temperature
Area specific air flow rate
Loading

23°C 0,5 m³/(m²h) 2 m²/m³ AgBB- Result review (28 days)

Designation	Value	Unit		
TVOC (C6 - C16)	27	µg/m ³		
Sum SVOC (C16 - C22)	<5	µg/m ³		
R (dimensionless)	0.00	-		
VOC without NIK	27	µg/m ³		
Cancerogens	n.d	µg/m ³		

Detection limit 1 µg/m²

n.d: not detected

8. References

Institut Bauen und Umwelt

Institut Bauen und Umwelt e.V., Berlin(pub.): Generation of Environmental Product Declarations (EPDs);

General principles

for the EPD range of Institut Bauen und Umwelt e.V. (IBU), 2013/04 www.bau-umwelt.de

ISO 14025

DIN EN ISO 14025:2011-10: Environmental labels and declarations — Type III environmental declarations — Principles and procedures

EN 15804

EN 15804:2012-04+A1 2013: Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products

PCR guideline texts for building-related products and services, Part B: Requirements on the EPD for ETFE components, 2012-07

GaBi 6 Software & Documentation

Data base for comprehensive analysis LBP, University of Stuttgart and PE International, Documentation of GaBi 6 data sets http://documentation.gabisoftware.com/, 2013

CML 2010: CML 2001 – November 2010: Characterisation factors developed by Institute of Environmental Sciences (CML); University Leiden http://www.cml.leiden.edu/software/data-cmlia.html

DIN EN ISO 9001:2008-12: Quality management systems – Requirements

EN 13501-1: 2012-1, Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests

BRUMI H2954fs: Emission tests of ETFE foils for VVOC, VOC and SVOC according to AgBB/DIBt requirements for building materials, Bremer Umweltinstitut, Bremen, Germany, 2009

AgBB 2010: Procedure for health-related evaluation of the emissions of volatile organic compounds (VOC and SVOC) from construction products, Committee for health-related evaluation of construction products, Dessau-Roßlau, Germany, May 2010

ArbSchG §5: §5 of the German Occupational Safety Act, Assessment of working conditions, in: Law on implementing occupational safety measures for improving the safety and health protection of employees in the workplace

AVV 2012: Directive on the European List of Waste Materials: Waste List Regulations dated 10 December 2001 (BGBI. I, p. 3379), last amended by Article 5, section 22 of the law dated 24 February 2012 (BGBI. I p. 212)

Acerboni et al. 2001: Acerboni G., Beukes J.A., Jensen N.R., Hjort J., Myrhe G., Nielsen C.J., Sundet J.K. (2001), Atmospheric degradation and global warming potentials of three perfluoralkenes. Atmospheric Environment (34), 4113-4123

REACH: Registration, Evaluation, Authorization and Restriction of Chemicals, 2007

EN ISO 527-1: 2012: Plastics – Determination of tensile properties – Part 1: General principles

ISO-2286-2(1998): Rubber or plastics coated fabrics -Determination of roll characteristics Part 2: Methods for determination of total mass per unit area, mass per unit area of coating and mass per unit area of substrate

DIN 53363: Testing of plastic films - Tear test using trapezoidal test specimen with incision

ASTM D4591-07(2012): Standard test method for determining temperatures and heats of transitions of fluoropolymers by differential scanning calorimetry

DIN EN ISO 4892-1: 2001-09: Plastics – Methods of exposure to laboratory light sources – Part 1: General guidance (ISO 4892-1: 1999); German version EN ISO 4892-1: 2001

DIN EN ISO 4892-2:2013-06: Plastics – Methods of exposure to laboratory light sources – Part 2: Xenonarc lamps (ISO 4892-2:2013); German version EN ISO 4892-2:2013

ISO 15099:2003: Thermal performance of windows, doors and shading devices - Detailed calculations

OHRIS 2009: Registration office of the State institute for occupational safety and product safety (AP) of the Bavarian State Office for Health and Food Safety (LGL), Munich, www.lgl.bayern.de/arbeitsschutz

TRGS 900: Technical rules for hazardous substances 900, Occupational exposure limit values, edition: January 2006, last amended and supplemented: GMBI 2013 S. 943-947 dated 19.09.2013 [No. 47]

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