Environmental Product Declaration

TEXLON® System

Transparent ETFE (ethylene tetrafluoroethylene) foil cushions pneumatically stabilized and fixed by an aluminium profile system

TEXLON® foil cushions for use as building envelope (roof and facade) suitable for new building, as well as for building in existing structures

vector foiltec

Over 30 years ago Vector Foiltec discovered that the outstanding mechanical and optical properties of ETFE foils were perfectly suited for architectural cladding systems.

Vector Foiltec developed Texlon® ETFE cladding systems using high quality products from Dyneon GmbH, manufacturer of the raw material, and Nowofol GmbH, manufacturer of the foils. Texlon®'s high transparency over the entire solar spectrum qualifies it as the best choice for biospheres, habitats and other enclosed spaces. Its tensile strength combined with its high flexibility characterizes Texlon® as a fail-safe building envelope.

A recent comparative study between Texlon® and glazed cladding systems indicated that the total mass required for a roof structure when using glass as the transparent system component is up to 7 times the mass required for an ultralight Texlon® solution.

Vector Foiltec fully promotes commercial, ecological, economic and social sustainability in the construction industry.

For more information visit:
www.vector-foiltec.com

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
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Institut Bauen und Umwelt e.V.

Registered under the scope of mutual recognition between UL Environment and Institut Bauen und Umwelt e.V. (IBU)

ENVIRONMENTAL PRODUCT DECLARATION

Vector Foiltec GmbH, Nowofol Kunststoffprodukte GmbH & Co. KG, Dyneon GmbH
Texlon®-System

According to EN 15804 and ISO 14025
Dual Recognition by UL Environment and Institut Bauen und Umwelt e.V.

This declaration is an environmental product declaration (EPD) in accordance with ISO 14025. EPDs rely on Life Cycle Assessment (LCA) to provide information on a number of environmental impacts of products over their life cycle. Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc. Accuracy of Results: EPDs regularly rely on estimations of impacts, and the level of accuracy in estimation of effect differs for any particular product line and reported impact. Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. EPDs from different programs may not be comparable.
By using this EPD, the user agrees to the UL ENVIRONMENT SUSTAINABLE PRODUCT GUIDE TERMS OF USE (http://productguide.ulenvironment.com/TermsandConditions.aspx), where this EPD is listed.

PROGRAM OPERATOR	UL Environment
DECLARATION HOLDER	Vector Foiltec GmbH, Nowofol Kunststoffprodukte GmbH & Co. KG, Dyneon GmbH
ULE DECLARATION NUMBER	4786535815.101.1
IBU DECLRATION NUMBER	EPD-DVN-20140043-IBE1-EN
DECLARED PRODUCT	Texlon®-System
REFERENCE PCR	Product Category Rules Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Background Report, 2013-04 Product Category Rules Part B: ETFE construction element, 2012-07

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CONTENTS OF THE DECLARATION	General information Product / Product description LCA calculation rules LCA scenarios and further technical information LCA results References

The PCR review was conducted by:	IBU – Institut Bauen und Umwelt e.V. PCR was approved by the IBU´s Independent Expert Committee
The CEN Norm EN 15804 serves as the core PCR. This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories ☐ INTERNAL ☒ EXTERNAL	 Wade Stout
This life cycle assessment was independently verified in accordance with EN 15804 and the reference PCR by:	IBU – Institut Bauen und Umwelt e.V.

Environment

Disclaimer

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General information

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Texlon® System

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Declaration number
EPD-DVN-20140043-IBE1-EN

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

This Declaration is based on the Product Category Rules:
ETFE construction element, 07-2012
(PCR tested and approved by the independent expert committee of IBU)

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.

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Issue date
06.05.2014

Valid to
05.05.2019

Verification

The CEN Norm EN 15804 serves as the core PCR
Independent verification of the declaration according to ISO 14025
☐ internally ☒ externally

Prof. Dr.-Ing. Horst J. Bossenmayer
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Dr. Burkhart Lehmann
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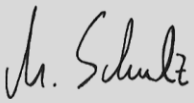

Matthias Schulz
(Independent verifier appointed by the independent expert committee)

Product

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 µm and 300 µm 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.

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

Technical Data

Unless otherwise stated the following data refers to an ETFE foil with a thickness of 200 µm.

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 /DIN EN ISO 527-1/	> 40	N/mm^2
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 mechanical changes	-

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 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 biocidals are used.

Reference service life

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

LCA: Calculation rules

Declared Unit

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

Name	Value	Unit
Declared unit	1	m^2
Conversion factor to 1 kg	5.13	-

System boundary

In addition to production, this LCA considers installation, energy consumption during use and disposal. It represents a cradle-to-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

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.

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*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

Reference service life

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

Name	Value	Unit
Reference service life	25 - 50	a

Operational energy (B6) and water (B7)

Name	Value	Unit
Water consumption	0	m^3
Electricity consumption pro a*m²	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 product)	5.13	kg
Collected as mixed construction waste	0	kg
Reuse	0	kg
Recycling aluminium profile	4.02	kg
Thermal recycling Seals	0.212	kg

Recycling: Scenario 1, foil cushions	0.896	kg
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.

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			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARYS
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	MND	MND	MND	X	MND	MND	X	X	X	X

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

CML-IA version 3.9, November 2010

Para-meter	Unit	A1 - A3	A4	A5	B6	C2	C3/1	C3/2	C4/1	C4/2	D/1	D/2
GWP	[kg CO_2-Eq.]	4.07E+1	1.83E+1	5.75E-1	1.32E-1	1.05E-1	5.75E-1	0.00E+0	2.52E-1	1.50E+0	-2.46E+1	-1.97E+1
ODP	[kg CFC11-Eq.]	1.85E-6	1.18E-10	3.57E-12	1.18E-10	1.84E-12	3.22E-10	0.00E+0	2.67E-11	4.28E-11	-8.79E-7	-5.86E-9
AP	[kg SO_2-Eq.]	1.73E-1	5.55E-2	5.21E-5	6.25E-4	2.75E-4	1.03E-3	0.00E+0	5.02E-4	1.81E-2	-1.26E-1	-1.09E-1
EP	[kg $(PO_4)^{3-}$- Eq.]	1.02E-2	1.10E-2	1.08E-5	3.29E-5	5.70E-5	1.44E-4	0.00E+0	2.34E-5	5.62E-5	-6.30E-3	-4.99E-3
POCP	[kg Ethen Eq.]	1.26E-2	4.99E-3	5.09E-6	3.68E-5	-6.99E-5	7.49E-5	0.00E+0	2.03E-5	4.23E-5	-7.18E-3	-5.95E-3
ADPE	[kg Sb Eq.]	9.54E-5	6.11E-7	5.18E-9	1.82E-8	3.92E-9	9.54E-8	0.00E+0	1.88E-8	2.11E-7	-2.52E-5	-8.21E-6
ADPF	[MJ]	5.84E+2	2.56E+2	1.00E-1	1.50E+0	1.45E+0	5.71E+0	0.00E+0	6.31E-1	1.18E+0	-2.71E+2	-1.94E+2

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

TRACI 2.1

Para-meter	Unit	A1 - A3	A4	A5	B6	C2	C3/1	C3/2	C4/1	C4/2	D/1	D/2
GWP	[kg CO_2-Eq.]	4.05E+01	1.83E+01	1.44E-01	1.70E-01	1.05E-01	5.67E-01	0.00E+00	1.31E-01	1.38E+00	-2.46E+01	-1.97E+01
ODP	[kg CFC11-Eq.]	1.86E-06	1.25E-10	3.78E-12	1.03E-10	1.95E-12	3.43E-10	0.00E+00	2.85E-11	4.56E-11	-8.80E-07	-6.24E-09
AP	[kg SO_2-Eq.]	1.65E-01	6.97E-02	6.43E-05	3.13E-04	3.42E-04	1.07E-03	0.00E+00	5.88E-04	2.12E-02	-1.18E-01	-1.02E-01
EP	[kg N-Eq.]	6.44E-03	3.79E-03	4.25E-06	2.53E-05	2.62E-05	1.75E-04	0.00E+00	1.65E-05	3.10E-05	-3.32E-03	-2.20E-03
SFP	[kg O_3-Eq.]	1.67E+00	2.06E+00	1.41E-03	4.50E-03	6.33E-03	1.57E-02	0.00E+00	3.84E-03	8.41E-03	-1.08E+00	-9.03E-01

Caption	GWP = Global warming potential ; ODP = Depletion potential of the stratospheric ozone layer ; AP = Acidification potential of land and water; EP = Eutrophication potential; SFP = Ground-level smog formation potential

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

Parameter	Unit	A1 - A3	A4	A5	B6	C2	C3/1	C3/2	C4/1	C4/2	D/1	D/2
PERE	[MJ]	1.25E+2	-	-	-	-	-	0.00E+0	-	-	-	-
PERM	[MJ]	0.00E+0	-	-	-	-	-	0.00E+0	-	-	-	-
PERT	[MJ]	1.25E+2	5.57E-1	1.05E-2	3.88E-1	5.70E-2	1.54E+0	0.00E+0	3.26E-2	1.02E-1	-9.07E+1	-8.36E+1
PENRE	[MJ]	5.73E+2	-	-	-	-	-	0.00E+0	-	-	-	-
PENRM	[MJ]	1.60E+1	-	-	-	-	-	0.00E+0	-	-	-	-
PENRT	[MJ]	5.89E+2	2.56E+2	1.16E-1	2.33E+0	1.45E+0	7.93E+0	0.00E+0	6.84E-1	1.34E+0	-3.33E+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	-	-
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
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
FW	[m³]	3.52E-1	6.69E-3	1.350E-3	1.04E-3	6.33E-5	2.47E-3	0.00E+0	9.35E-4	4.50E-3	-2.57E-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; 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	C3/1	C3/2	C4/1	C4/2	D/1	D/2
HWD	[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	-1.47E-2	3.01E-3
NHWD	[kg]	4.51E+0	1.86E-3	5.18E-5	1.01E-3	1.89E-4	9.07E-3	0.00E+0	1.93E-2	2.91E-1	-3.06E+0	-2.97E+0
RWD	[kg]	4.07E-2	2.48E-4	6.40E-6	3.42E-4	2.02E-6	9.17E-4	0.00E+0	2.16E-5	6.69E-5	-2.54E-2	-2.14E-2
CRU	[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	-	-
MFR	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	4.02E+0	8.78E-1	0.00E+0	0.00E+0	0.00E+0	-	-
MER	[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	-	-
EEE	[MJ]	0.00E+0	0.00E+0	7.99E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.57E-1	1.74E+0	-	-
EET	[MJ]	0.00E+0	0.00E+0	1.92E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	7.70E-1	4.95E+0	-	-

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; EET = 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.

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