SUSTAINABILITY CONTRIBUTION DECLARATION

LEED v4®
(Leadership in Energy and Environmental Design)

The intention of this document is to support the LEED certification process by providing specific information. The basis of this information is the LEED v4 (http://www.usgbc.org/leed-v4).

Texlon® System with Fluon® ETFE FILM

The Texlon® System is based on the following principle: single layer Fluon® ETFE (ethylene tetrafluoroethylene) foil membranes or pneumatically stabilised ETFE foil cushion elements are fixed to a sub-structure by means of a high-quality aluminum frame system. The system comprises of between one and six layers of Fluon® ETFE foil depending on the building physics, static or design requirements and specifications. U- and g-values are defined inter alia by the number of foil layers, the type of coating, as well as the type of foil used for set-up. The Fluon® ETFE foil thickness varies between 80 µm and up to 500 µm depending on the structural construction requirements. For cushion systems, the individual layers are welded together at the edges and connected by ETFE valves and flexible pipes to a low-pressure air system of approximately 220 Pa (220 N/m²) for stabilisation.
The declared product in this factsheet represents an average system of the Vector Foiltec production year 2015, based on a typical 3-layer system with the following set-up:

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

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Sustainable Sites (SS)

Heat Island Reduction
→ To minimize effects on microclimates and human and wildlife habitats by reducing heat islands.

Product information

Item	Value	Unit
solar reflectance index (SRI) value (roofing materials) (3 year aged)	0,01-0,6	-

Depending on the configuration of the Texlon® System, the SRI can range from 1% to 60%. Vector Foiltec can provide specific values for each project.

Innovation (IN)

→ To encourage projects to achieve exceptional or innovative performance.

Description:
None of the existing pilots for the innovation credit apply – for a specific certification project, the detailed data will be provided by Vector Foiltec.

Materials & Resources (MR)

Building life-cycle impact reduction
→ To encourage adaptive reuse and optimize the environmental performance of products and materials.

Option 4*:* Conduct a life-cycle assessment of the project's structure and enclosure that demonstrates a minimum of 10% reduction, compared with a baseline building in at least three impact categories. Note: No impact category assessed as part of the life-cycle assessment may increase by more than 5% compared with the baseline building.
The LCA showed an increase of depletion potential of the stratospheric ozone layer, which is caused by the electricity demand of the use phase. A specific LCA is advised to obtain the credits.

The introduction of transparent Texlon® ETFE roof cladding systems in modern architecture will significantly contribute not only to environmental sustainability, but will also create economic and social advantages compared to more classic building materials. The environmental benefits of Texlon® ETFE foil cladding systems are presented as results of in a comparative study between glass and ETFE solutions on two projects in Germany, Domaquarée in Berlin and Kapuzinergraben in Aachen, based on a life cycle analysis[1].

[1] Maywald, C.; F. Riesser, Sustainability – the art of modern architecture, Procedia Engineering, Vol. 155 (2016) 238-248

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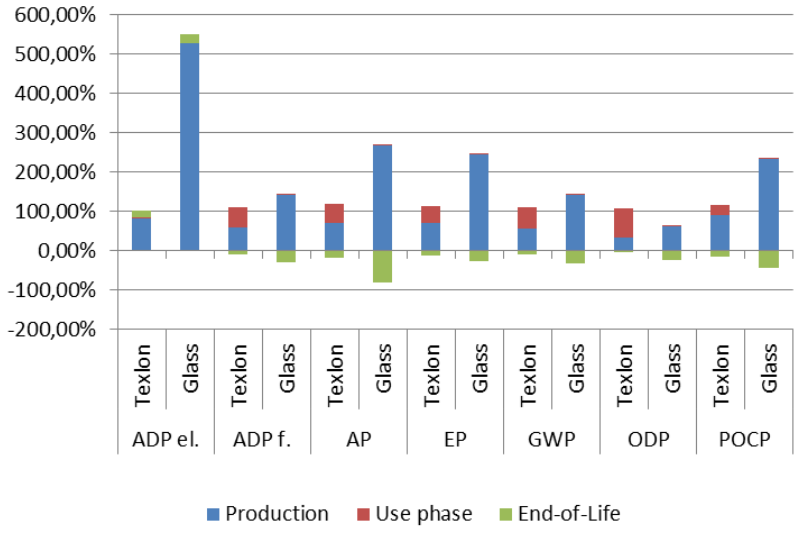
Absolute quantity of materials and percentage of total mass required for each roof type

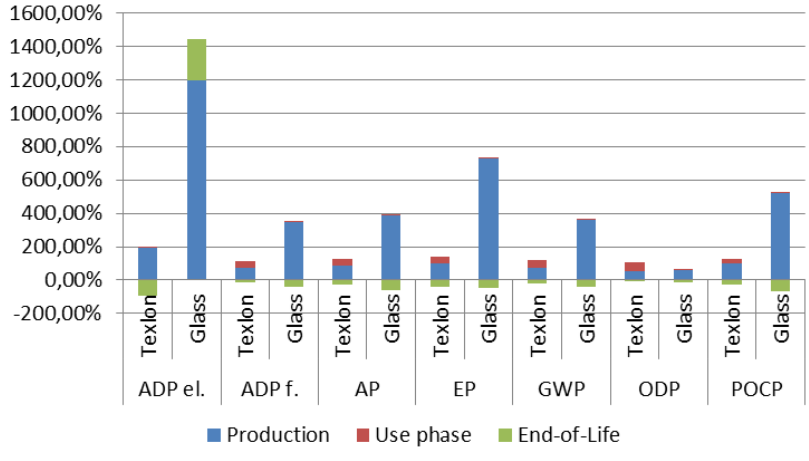
Project	Domaquarée				Kapuzinergraben			
Alternative	**Texlon® roof**		**Glass roof**		**Texlon® roof**		**Glass roof**	
Weight	**kg**	**%**	**kg**	**%**	**kg**	**%**	**kg**	**%**
Steel	95466	*94.74*	103066	*55.74*	12250.39	*91.07*	78270.40	*80.71*
Aluminum	3719	*3.69*	22103	*11.95*	801.80	*5.96*	1000	*1.03*
ETFE	1323	*1.31*	-	-	352.00	*2.62*	-	-
Glass	-	-	59311	*32.08*	-	-	17601	*18.15*
EPDM	216	*0.21*	420	*0.23*	38.10	*0.28*	102.5	*0.11*
PP	33	*0.03*	-	-	9.18	*0.07*	-	-
Total	**100756**	***100***	***184900***	***100***	***13451.5***	***100***	**96973.90**	***100***

Environmental impacts normalized for Texlon® roof

a) Domaquarée



b) Kapuzinergraben



SUSTAINABILITY CONTRIBUTION DECLARATION

Building product disclosure and optimization - environmental product declarations
→ To encourage the use of products and materials for which life-cycle information is available and that have environmentally, economically, and socially preferable life-cycle impacts.

Product information

Item	Value
Critically reviewed LCA acc. to ISO 14044?	Yes
Reviewer	External reviewer
Author of the LCA	thinkstep AG
Download link of the document/study	https://epd-online.com/EmbeddedEpdList/Download/9942
Industry-wide (generic) EPD (Type III, incl. external verification)?	No
Product specific EPD (Type III, incl. external verification)?	Yes
EPD program operator	Institute Construction and Environment (IBU - Institut Bauen und Umwelt e.V.), Berlin
EPD program operator country	Germany
EPD number	EPD-VFA-20170121-IBE1-EN
Declared unit	1 m² of an average Texlon® foil cushion incl. frame with of 4.56 kg/m² mass per unit area.
End-of-Life Scenario	Scenario 1: thermal treatment of Fluon® ETFE foil Scenario 2: recycling of Fluon® ETFE foil

Results of the LCA – ENVIRONMENTAL IMPACTS

Life cycle stages	Product stage	Constr. process stage		Use stage	End of Life Stage						Benefits & loads beyond system bound.	
Declared life cycle stages (EN 15804)	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

Note: Detailed names of the given abbreviations can be found in the Glossary.

Materials & Resources (MR)

Building product disclosure and optimization - environmental product declarations (continued)

Results of the LCA – RESOURCE USE

Life cycle stages	Product stage	Constr. process stage		Use stage	End of Life Stage						Benefits & loads beyond system bound.	
Declared life cycle stages (EN 15804)	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

Results of the LCA – OUTPUT FLOWS AND WASTE CATEGORIES

Life cycle stages	Product stage	Constr. process stage		Use stage	End of Life Stage						Benefits & loads beyond system bound.	
Declared life cycle stages (EN 15804)	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

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Materials & Resources (MR)

Building product disclosure and optimization – sourcing of raw materials
→ To encourage the use of products and materials for which life-cycle information is available and that have environmentally, economically and socially preferable life-cycle impacts and sourcing.

Product information

Option 1. raw material source and extraction reporting (1 point)		**Description / Unit**
Third-party verified corporate sustainability report (CSR)?	No	-
Option 2. leadership extraction practices (1 point)		**Description / Unit**
Participation in an extended producer responsibility program?	Yes	Vector Foiltec has established a take-back system for the complete Texlon® system within Europe and is extending this worldwide in order to allow for recycling of most of the parts used in a project. ETFE off-cut and waste from production is 100% recycled into valves.
Materials reuse	No	-
Post-consumer recycled content	Yes	45 % of the aluminum frame is post-consumer recycled content
Pre-consumer recycled content	Yes	Valves connecting the foil cushions to the air supply system are 100% produced from pre-consumer recycled ETFE (0.2 % of total weight of the 3-layer foil cushion)

Building product disclosure and optimization – material ingredients
→ To reward the selection of products verified to minimize the use and generation of harmful substances based on an accepted methodology for chemical ingredient listing.

Product information

Type of reporting	**Certification program (e.g. Green screen, cradle to cradle, REACH)**	**Value/Comment**
Option 1: material ingredient reporting	Health Product Declaration	Yes, The Texlon® HPD can be downloaded under https://portico.healthymaterials.net/data/records/949 Background data are available on request at Vector Foiltec.
	Manufacturer Inventory	No
Option 2: Material	GreenScreen v1.2 Benchmark	No
	Cradle to Cradle Certified	No

ingredient optimization	International Alternative Compliance Path – REACH Optimization	Yes, the Texlon® system does not contain substances that meet REACH criteria for substances of very high concern (see also Safety data sheet).
	USGBC approved program	No

Indoor Environmental Quality (IEQ)

Low-emitting materials
→ To reduce concentrations of chemical contaminants that can damage air quality, human health, productivity, and the environment.

Product information

Item	Value
Test institute / organization	Environmental Institute „*Bremer Umweltinstitut – Gesellschaft für Schadstoffanalysen und Begutachtung mbH*“ (commissioned by Vector Foiltec GmbH)
Test method applied	Committee for Health-related evaluation of Building Products - AgBB Scheme (2010) and DIN ISO 16000-3:2013-01
Measurement conditions	Temperature 23°C Area specific air flow rate 0.357 $m^3/(m^2h)$ Loading 1.4 m^2/m^3
Results	**AgBB Test results (28 days)** TVOC (C_6 - C_{16}) 27 $\mu g/m^3$ Sum SVOC (C_{16} - C_{22}) < 5 $\mu g/m^3$ R (w/o dimension) 0 VOC w/o NIK 27 $\mu g/m^3$ Carcinogenic Substances * Formaldehyde * * not detectable
Test institute / organization	**SINTEF** Byggforsk **SINTEF** Building and Infrastructure NO-0314 Oslo, Norway
Test method applied	Leaching Test according to PD/CEN TS 16637-2:2014 – *Construction Products. Assessment of release of dangerous substances. Horizontal dynamic surface leaching test*
Measurement conditions	Sample size: 0,03 m x 0,083 m Exposed surface area: 0,00498 m^2 Leachate: deionised water, resistivity 18MΩ cm leachate volume: 0,4 L L/A-ratio: 80 L/m^2 Container: Glass bottle Room temperature – testing: 23 ± 2 °C Analysis of leachate: Elements – As, CD, Co, Cr, Cu, Mo, Ni, Pb, V, Zn Method: ICP – SFMS Screening for organic compounds Method: head space GC-MS pH
Results	The cumulative release of substances was calculated from the leachate concentrations (see following table)

Parameter	Release[mg/m²]			
	Step 1	Step 2	Step 3	Step 4
As (arsenic)	0-0.8	0-1.3	0-1.7	0-2.1
Cd (cadmium)	0.02	0.03	0.03-0.05	0.03-0.07
Co (cobalt)	0.05	0.12	0.12-0.16	0.12-0.2
Cr (chromium)	0.4	1.9	2.7	3.6
Cu (copper)	2.5	13	391	397
Mo (molybdenum)	0-0.4	0-0.8	0-1.2	0-1.6
Ni (nickel)	1	1.9	3.1	3.5
Pb (lead)	0.4	1.0	1.4	1.8
V (vanadium)	0.1	0.2	0.3	0.3-0.7
Zn (zinc)	8	20	28	48
Organic compounds[1)]	n.d[1)]	n.d. [1)]	n.d[1)]	n.d. [1)]

1) Not detected (n.d.). No detection level reported.

Daylight
→ To connect building occupants with the outdoors, reinforce circadian rhythms, and reduce the use of electrical lighting by introducing daylight into the space.

Transparency
ETFE Foil is very transparent across the visible light region (380-780 nm) with a transparency of approximately 90% of total light. Transmission across the ultraviolet range (320nm - 380nm) is also very good at 80% as well as in the near infrared (IR) range (780nm - 3000nm) at 90%, which is very important for plant growth (photosynthetically active radiation PAR). It is also important to note that ETFE foil has high absorption in the infrared range (room temperature of 23°C, 10µm respectively), a property that can be exploited to reduce buildings' energy consumption.

Solar Control
Whilst the base material is very transparent, Texlon® ETFE foil can be treated in a number of different ways to manipulate its transparency and radiation transmission characteristics.

Colour
Texlon® ETFE foil can be manufactured in a wide range of colours to suit any application. Coloured foils can be welded to transparent foils allowing the incorporation of large scale graphics and branding of building envelopes. When combined with projected light, the effects can be outstanding.

Radiation
Texlon® ETFE foil can be treated with selective radiation applications to reduce the amount of UV and IR light passing through the building envelope.

Printing
The surface of the ETFE foil can be printed with a wide range of graphic patterns to change its visible appearance and affect the amount of light and solar energy passing through it.
The energy transmission is affected by both the percentage of coverage and the density of the ink, both of which are variable, whilst the visual appearance is affected by the pattern and size of the graphics used. For example, a print of 5mm dots with 65% coverage looks completely different from a print of 50mm dots with 65% coverage although they have identical technical performances.

Variable Shading
By printing overlapping graphics on multiple layers and integrating the cushions with sophisticated pneumatics, the different graphics can be moved together and apart from each other. This enables us to vary the amount of light and solar energy penetrating the building and the visual appearance of the envelope.

SUSTAINABILITY CONTRIBUTION DECLARATION

Acoustic performance
→ To provide workspaces and classrooms that promote occupants' well-being, productivity, and communications through effective acoustic design.

Product information

Results[2] have confirmed that the application of ETFE will, thanks to its acoustic properties, contribute to the enhanced room acoustic comfort. In comparison with a glass or polycarbonate, rooms covered by structural skins have shorter reverberation time at low and middle frequencies. However acoustic comfort in large halls cannot be completely reached by roofing structure due to its relatively small surface area (in comparison with overall surface area of interior structures). Finally, it is important to realize, that although typical membrane structures have a higher sound absorbing properties than hard materials such as glass, they have usually poorer sound insulation. This might result in an increase of the background noise levels inside the halls, in cases in which buildings are located in noisy areas. Also, the drumming effect caused by heavy rain should be mentioned as a case of disturbance in any cases. Thanks to the development of a rain suppression system (patent EP 1 353 025 B1, US 6,860,069 B2) the rain drumming noise can be reduced by 10dB.

[2] Urbán, Daniel; Julia Zrnekova; Peter Zat'ko; Carl Maywald; Monika Rychtáriková, Acoustic comfort in atria covered by novel structural skins, Procedia Engineering 155 (2016) 361-368

SUSTAINABILITY CONTRIBUTION DECLARATION

General Information

Company name:	Vector Foiltec GmbH
Address:	Steinacker 3, 28717 Bremen, Germany
Contact person:	Dr. Carl Maywald
Phone:	+49 421 69351-0
Email:	us@vector-foiltec.com
Homepage:	www.vector-foiltec.com
Date of this fact sheet:	27.09.2017

Further product declarations

Health Product declaration (HPD)

Number	HPD 12746-20150720062720
Publisher	Portico
Download	https://portico.healthymaterials.net/data/records/949
Hardcopy	Vector Foiltec GmbH

Technical data

Average mass shares of main components:

Component	Mass share
Aluminum frame	ca. 71.9%
AGC Fluon® ETFE film	ca. 19.2 %
Silicon gasket	ca. 8.1 %
PP Keder	ca. 0.8 %
ETFE valves	ca. 0,0 %

Glossary

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
PE total	Total use of primary energy resources (=PERT+PENRT)
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
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
EE	Exported energy per energy carrier