SUSTAINABILITY CONTRIBUTION DECLARATION

BREEAM®
(Building Research Establishment Environmental Assessment Method)

The intention of this document is to support the BREEAM certification process by providing building specific information. This information refers to the BREEAM UK New Construction technical manual (2014) [1]

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.

[1] BREEAM UK New Construction non-domestic buildings technical manual 2014; Reference: SD5076 – Issue: 1.0; Date: 21/05/2014, www.breeam.org

Management

Man 02: Life cycle cost and service life planning
→ To deliver whole life value from investment and promote economic sustainability by recognising and encouraging the use and sharing of life cycle costing and service life planning.

Product information

Specific information	Evidence (quality)
Construction process stage	The reference service life of Texlon® ETFE foil cladding systems is presented 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[2].
Use stage	**Reference service life** (RSL): > 30 years

Man 04: Commissioning and handover
→ To encourage a properly planned handover and commissioning process that reflects the needs of the building occupants.

Product information

Product specific information for the Building User Guide (BUG) (installation, maintenance)	Evidence (quality)
Maintenance instructions	Thanks to the extremely low surface energy of Fluon® ETFE, which are comparable to PTFE, any kind of dirt or contamination will hardly stick on the surface. Typically, the surface of the outer foil is cleaned by natural rain. Accordingly, no additional cleaning procedure is required. Moreover, Fluon® ETFE foils cannot be affected by any kind of environmental pollution and they are highly resistant to exterior wind pressure and tensile loads owing to their extraordinary elongation properties. In case the Fluon® ETFE foils cannot be cleaned by means of natural rain nor sprinkling, Vector Foiltec will provide information on cleaning procedures. It is essential that the Texlon® ETFE systems are correctly maintained to ensure optimal performance and longevity of both static and moving components. To ensure optimal performance Vector Foiltec recommends to agree on a regular maintenance service.

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

Health and Wellbeing

Product information

HEA 01: Visual comfort
→ To ensure daylighting, artificial lighting and occupant controls are considered at the design stage to ensure best practice in visual performance and comfort for building occupants.

Specific information	Evidence (quality)
Transparency	Fluon® 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 (UV) 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 Fluon® ETFE foil has high absorption in the infrared range (room temperature of 23°C, 10µm respectively), a property that can be exploited to reduce a 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 Fluon® 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.

HEA 02: Indoor air quality
→ To recognise and encourage a healthy internal environment through the specification and installation of appropriate ventilation, equipment and finishes.

Product information

ETFE is absolutely inert. Basic information regarding health performance of the Texlon® System are documented in the Texlon® Health Product Declaration HPD. The Texlon® HPD can be downloaded under https://portico.healthymaterials.net/data/records/949

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 µg/m^3 Sum SVOC (C_{16} - C_{22}): < 5 µg/m^3 R (w/o dimension): 0 VOC w/o NIK: 27 µg/m^3 Carcinogenic Substances: * Formaldehyde: * * not detectable

HEA 04: Thermal comfort
→ To ensure that appropriate thermal comfort levels are achieved through design, and controls are selected to maintain a thermally comfortable environment for occupants within the building.

Product information

Specific information	Value and evidence
Thermal conductivity (W/mK)	0.24
U-value (W/m²K)	0.5 – 5.86 In order to control the thermal properties of a Texlon® ETFE cladding system the number of ETFE layers can vary between one and six layers, i.e. ranging from no air chamber to 5 air chambers between the layers. Additionally air conditioning inside the building will significantly influence the U-value in hot climates. As the foil is transparent, it absorbs very little energy. Even the printed foils reflect the vast majority of the energy falling on their surface. Typically, the foils are between 80µm and 300µm thick. As the foils are very thin, they have a very large surface to volume ratio; meaning that any energy absorbed by the material is quickly dissipated by natural convection and conduction to the surrounding air. Typically, the inner

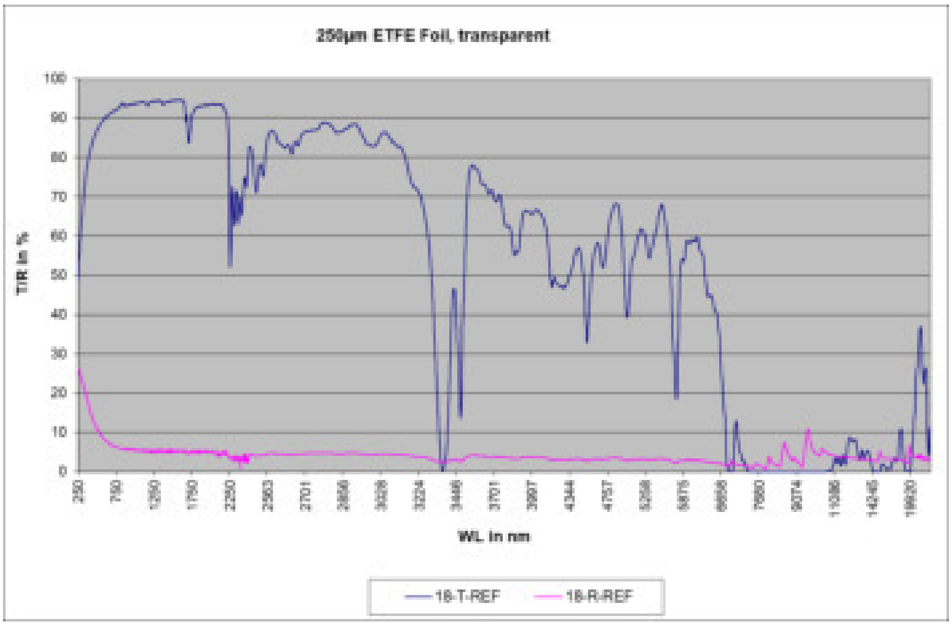
	surface of a cushion is within 1 or 2 degrees of the ambient air adjacent. As thermal comfort is a product of the solar energy passing through the roof and the radiant effect of other surfaces in the surroundings, the thermal comfort under a Texlon® ETFE roof is much better than under an equivalent glazed system.

Energy

Ene 01: Reduction of energy use and carbon emissions
→ To recognise and encourage buildings designed to minimise operational energy demand, primary energy consumption and CO_2 emissions.

Product information

Specific information	Evidence (quality)
	Texlon® ETFE systems significantly contribute to minimizing the operational energy demand for heating and cooling of a building by offering different technical solutions.
Control of U-value	By choosing the number of Fluon® ETFE layers for the cladding system the U-value can be adopted according to environmental conditions. Special attention has to be payed to specific local conditions, like northern climates or hot climates • Cold climates: $0.8 \leq$ U-value ≤ 5.86 W/m²K • Hot climates: $0.5 \leq$ U-value ≤ 5.88 W/m²K
Control of g-value, solar and visual transmission	There are different solutions for control of radiation that goes into a building. A basic property of ETFE is that it is opaque for thermal radiation in the range of 10µm, i.e. standard room temperature (see following graph).



	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 into the building and the visual appearance of the envelope. Visible transmission Tvis and g-value can be controlled as • 0.17 ≤ g-value ≤ 0.39 • 12.8% ≤ Tvis ≤ 27.4% Special pigments implemented into the foil allow for selective shading of, for instance, UV or IR radiation.

Ene 08: Energy efficient equipment
→ To recognise and encourage procurement of energy efficient equipment to ensure optimum performance and energy savings in operation.

Product information

Specific information	Evidence (quality)
	The electricity consumption to operate a typical Texlon® ETFE systems would be unlikely to make a significant contribution to the total annual unregulated energy consumption of the building. Typical electricity consumption for operation of the pneumatics in the reference system is 0.274 kWh per annum per m².

Materials

Mat 01: Life cycle impacts
→ To recognise and encourage the use of construction materials with a low environmental impact (including embodied carbon) over the full life cycle of the building.

Product information

Description	Value
"Independently verified third party Environmental Product Declaration (EPD) available?"	Yes https://epd-online.com/EmbeddedEpdList/Download/9942
EPD Program Operator	Institute Construction and Environment (IBU - Institut Bauen und Umwelt e.V.), Berlin
Author of the LCA	thinkstep AG
EPD Number	EPD-VFA-20170121-IBE1-EN
System boundaries	Cradle to grave
End-of-Life Scenario	Scenario 1: thermal treatment of Fluon® ETFE foil Scenario 2: recycling of Fluon® ETFE foil
Declared unit	1 m² of an average Texlon® foil cushion incl. frame with of 4.56 kg/m² mass per unit area.
PCR	ETFE construction element, 07.2014
Green guide rating	Please contact a BREEAM Assessor.

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

Mat 01: Life cycle impacts
(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

Mat 06: Material efficiency
→ To recognise and encourage measures to optimise material efficiency in order to minimise environmental impact of material use and waste-optimisation.

Product information

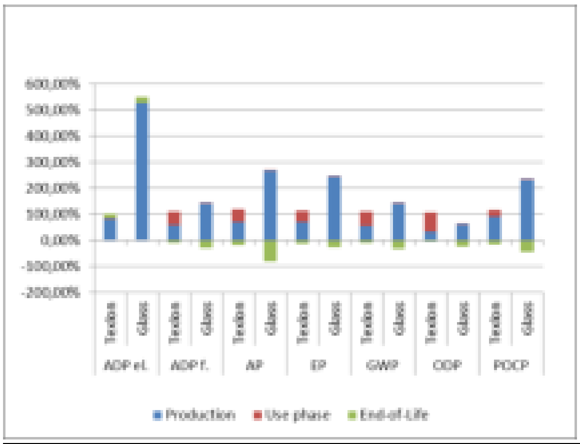
Specific information	Evidence (quality)
Construction process stage	Thanks to the extremely lightweight film, less supporting substructure is required relative to normal glazing. This leads to a higher material efficiency for the whole building The environmental benefits of Texlon® ETFE foil cladding 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[3].

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

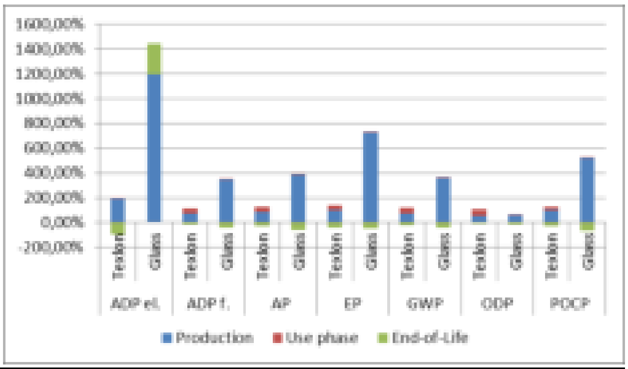
Project	Domaquarée				Kapuzinergraben			
Alternative	Texlon® roof		Glass roof		Texlon® roof		Glass roof	
Weight	kg	%	kg	%	kg	%	kg	%
Steel	95466	94.74	103066	55.74	12250.39	91.07	78270.40	80.71
Aluminum	3719	3.69	22103	11.95	801.80	5.96	1000	1.03
ETFE	1323	1.31	-	-	352.00	2.62	-	-
Glass	-	-	59311	32.08	-	-	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



Waste

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

Wst 01: Construction waste management
→ To promote resource efficiency via the effective management and reduction of construction waste.

Product information

Specific information	Evidence (quality)
Waste code	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
End of life stage	**Recycling by 100%:** Vector Foiltec offers to take back aluminium frames as well as the Fluon® ETFE foil for recycling

Water

Not relevant for this product.

Pollution

Not relevant for this product.

SUSTAINABILITY CONTRIBUTION DECLARATION

General Information

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Date:	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
BUG	Building User Guide: Dedicated building/site specific guidance for the non-technical building user. The purpose of the guide is to help building users access, understand and operate the building efficiently and in a manner in keeping with the original design intent. A Building User Guide will provide easily accessible and understandable information relevant to the following stakeholders: - The building’s staff (or where relevant residents) - The non-technical facilities management team/building manager - Other building users, e.g. visitors/community users

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