Statement of Verification

BREG EN EPD No: 000811 Issue: 01

This is to verify that the Environmental Product Declaration provided by:

Viritopia Limited

are in accordance with the requirements of:

EN 15804:2012+A2:2019

and

BRE Global Scheme Document SD207

This declaration is for:

100 m² ANS Living Wall system modelled with an aluminium top-hat subframe and planting media comprising peat, coir, and wood fibre (West+), with strawberry plants used as a proxy for ivy, over a 30-year study period, with a total system weight of 2,787.5 kg.

Company Address

Viritopia Limited
Aldingbourne Nurseries
Church Road, Aldingbourne
Chichester, PO20 3TU
United Kingdom

Signed for BRE Global Limited — Hayley Thomson, Operator

18 August 2026	18 August 2026	17 August 2031
Date of this Issue	Date of First Issue	Expiry Date

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Environmental Product Declaration

EPD Number: 000811

General Information

EPD Programme Operator	Applicable Product Category Rules
BRE Global Watford, Herts WD25 9XX United Kingdom	BRE Environmental Profiles 2025 Product Category Rules for Type III environmental product declaration of construction products to EN 15804+A2 PN 514 Rev 3.2
Commissioner of LCA study	**LCA consultant/Tool**
Viritopia Limited Aldingbourne Nurseries Church Road, Aldingbourne Chichester, PO20 3TU United Kingdom	LCA consultant: Chris Wilson - Trident Utilities LCA Tool: BRE LINA A2
Declared/Functional Unit	**Applicability/Coverage**
100 m² ANS Living Wall system modelled with an aluminium top-hat subframe and planting media comprising peat, coir, and wood fibre (West+), with strawberry plants used as a proxy for ivy, over a 30-year study period, with a total system weight of 2,787.5 kg.	Other (please specify). Representative Product
EPD Type	**Background database**
Cradle to Gate with options	Ecoinvent 3.8

Demonstration of Verification
CEN standard EN 15804 serves as the core PCR [a]
Independent verification of the declaration and data according to EN ISO 14025:2010 ☒Internal ☐ External
(Where appropriate [b]) Third party verifier: Kim Allbury
a: Product category rules b: Optional for business-to-business communication; mandatory for business-to-consumer communication (see EN ISO 14025:2010, 9.4)

Comparability
Environmental product declarations from different programmes may not be comparable if not compliant with EN 15804:2012+A2:2019. Comparability is further dependent on the specific product category rules, system boundaries and allocations, and background data sources. See Clause 5.3 of EN 15804:2012+A2:2019 for further guidance

Information modules covered

Product			Construction		Use stage							End-of-life					Benefits and loads beyond the system boundary
					Related to the building fabric					Related to the building							
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4		D
Raw materials supply	Transport	Manufacturing	Transport to site	Construction – Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal		Reuse, Recovery and/or Recycling potential
☑	☑	☑	☑	☑	☑	☑	☐	☐	☐	☑	☑	☑	☑	☑	☑		☑

Note: Ticks indicate the Information Modules declared.

Manufacturing site(s)

Viritopia Limited
Aldingbourne Nurseries
Church Road, Aldingbourne
Chichester, PO20 3TU
United Kingdom

Construction Product:

Product Description

The Viritopia modular living wall system is a vertical greening system designed for installation on building façades and external structures. The system comprises an aluminium top-hat subframe and associated support rails, onto which modular planting units are fixed.

Each modular unit contains an engineered growing substrate and planted vegetation suitable for external wall applications. The system includes integrated irrigation and infrastructure to support plant establishment and growth.

Primary construction components such as aluminium subframe elements, modular trays and irrigation components are manufactured by third-party suppliers and delivered to the nursery facility, where final assembly, planting and cultivation processes are undertaken prior to delivery to site.
The system is supplied as pre-grown modular panels ready for installation.

A living wall system is used in the built environment where limited space is an issue to include planting to provide a nature-based solution. A living wall system has been designed to utilise free available space ie the facade of a building.
When the correct plant species have been selected, the living wall system will:

- Enhance biodiversity by providing sources of pollen, nectar, fruits, berries, or nesting opportunities.
- Sequestrating air pollution, Carbon dioxide, Nitrogen oxide, VOC's & Particulate Matter.
- Providing additional thermal insulation to a building.
- Provide urban cooling by the process of Evapotranspiration and shading.
- Improving the aesthetics of the build environment.

The system is modular in design and can be configured to project-specific dimensions; for the purpose of this EPD, a reference configuration of 100 m² of modular living wall system, with a total mass of 2,787.5 kg, is defined as the declared unit.

Technical Information

Property	Value, Unit
Fire Classification	Class B- s2- d0
Carbon Sequestration of Living Wall	2.42 kg of CO2e/ m2

Reference service life (RSL)	30 years

NBS specification data web page - https://source.thenbs.com/product/viritopia-aluminium-top-hat-build-up/uf45YXz6qrsXhnCowu3o19/7chzqmFjqvL7VJA34dfkzp?previousVersion=kKBQ5b3LGtyKsWoeaTG12i

Main Product Contents

Material/Chemical Input	%
Living wall module	31.57%
Living wall Top-Hat sub-frame	7.75%
Living wall hanging rails	6.17%
Irrigation tank	0.43%
Irrigation tank	0.43%
irrigation tank lid	0.01%
Irrigation dripline	0.42%
Irrigation riser pipe	0.05%
Gutter components	0.23%
Breathable membrane	1.58%

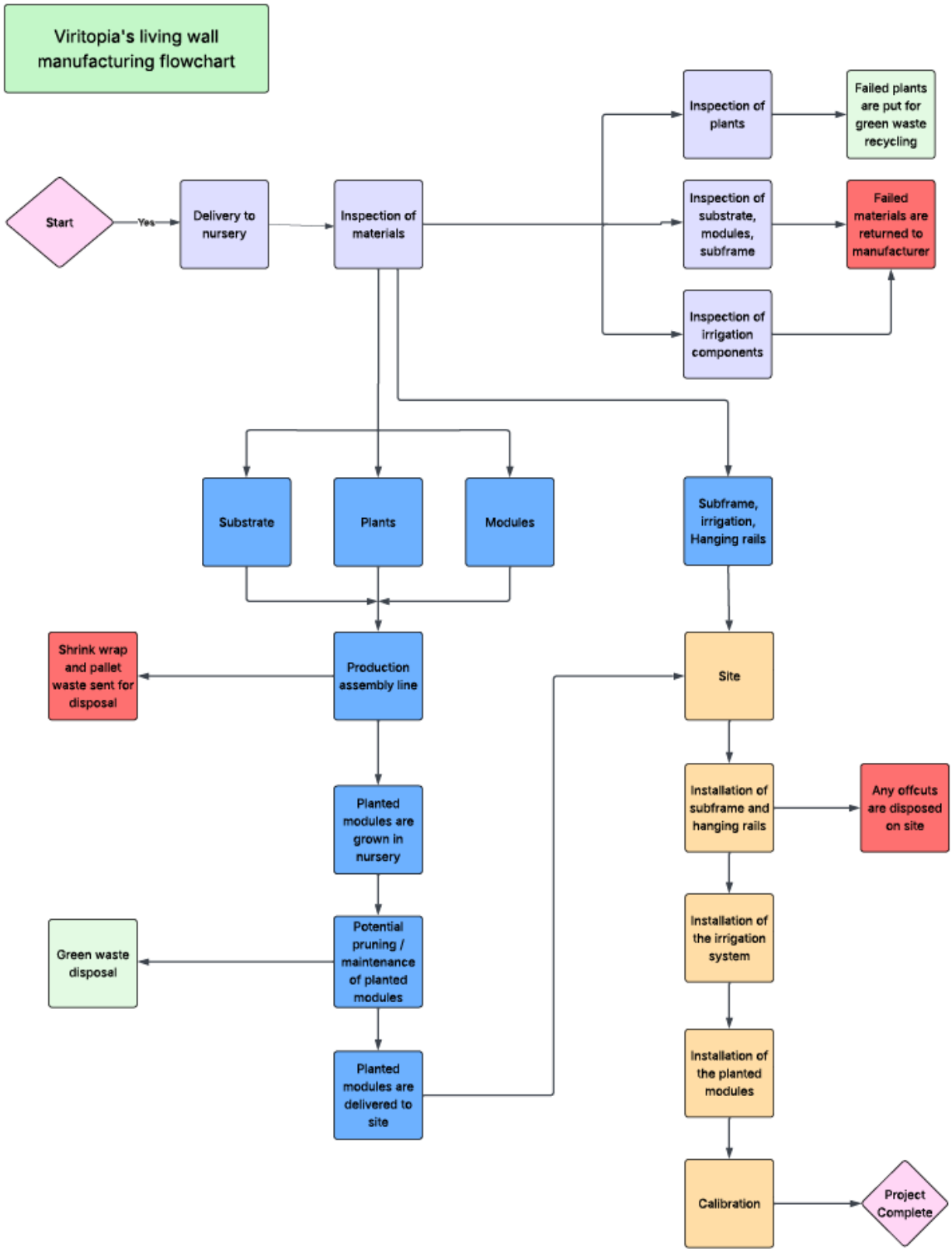
Material/Chemical Input	%
Capillary matting (inside module)	0.63%
Substrate	45.35%
Plants	4.31%
Dosatron	0.06%
Irrigation Pump,DAB Esybox Mini 3 60212601	0.97%
Irrigation controller	0.05%

Manufacturing Process

All primary construction system components (e.g. aluminium subframe elements, modular planting units, irrigation components, substrate materials and ancillary fixings) are manufactured by third-party suppliers and are therefore modelled as upstream processes within Module A1 (raw material supply).
These components are transported directly from suppliers to the nursery facility at Aldington and are modelled in Module A2 (transport to manufacturing).
At the nursery, the living wall modules are assembled, including installation of subframe elements within the modular system, filling with growing substrate, planting of purchased strawberry seedlings, and cultivation of plants to achieve the final product specification.
All activities undertaken at the nursery, including module assembly, planting operations, plant cultivation, irrigation, fertiliser application, and associated energy and water use, are therefore modelled within Module A3 (manufacturing).

- A design is created based on the client's preferences, the site's characteristics, and the desired aesthetic.
- A framework is built to support the weight of the growing medium, modules, plants, and water. This structure is constructed/ fabricated from aluminium alloy.
- An irrigation system is integrated into the framework to ensure consistent watering of the plants. This may involve pipes, drip lines,
- The appropriate growing medium is chosen based on the plants' needs and the chosen wall system.
- The living wall planting begins at a nursery. The living wall modules are placed onto a conveyor system which moves them beneath a hopper. The hopper dispenses the required volume of substrate into each module, before the substrate is lightly compacted to achieve a consistent fill level.
- The modules are hand lifted and placed on a trolley, and moved to the workstations
- At the workstations, the modules are planted in accordance with the planting plan.
- The modules are then hand watered using a hose and moved to the nursery where they are hung for a number of weeks to mature in size
- Once grown, the modules are hand lifted onto a trolley and loaded onto a truck and delivered to site.

Process flow diagram



Construction Installation

- A Mobile Elevating Work Platform (MEWP) is used to provide safe access for the installation of the living wall system.
- The installation begins by fixing vertical top-hat battens to the façade at 600 mm centres across the living wall area.
- A breathable membrane is then installed over the sub-frame within the living wall area.
- Aluminium hanging rails are fixed horizontally to the vertical battens at 500 mm vertical centres until the full framework is complete.
- Starting from the base of the living wall, the first row of pre-planted modules is hung and securely fixed to the hanging rails.
- A continuous length of irrigation dripline is then installed, with the drip emitters inserted into the top of each module along the row.
- Additional rows of planted modules and irrigation dripline are installed progressively until the living wall is complete.
- A gutter is installed at the base of the living wall, with the downpipe connected to the drainage system below.
- Within the plant room, the irrigation tank, pump, controller, Dosatron unit, and associated pipework and fittings are installed.
- The main irrigation pipework is then run from the plant room and connected to the dripline feeds serving the living wall.
- The irrigation system is tested and commissioned to confirm correct operation.
- Project complete.

Use Information

Monthly Health Check

A monthly maintenance visit is carried out to provide a visual inspection of the living wall and identify any potential issues before they develop further.

During the visit, the operative will:

- Check substrate moisture levels and adjust irrigation settings where required
- Inspect nutrient levels within the irrigation tank and top up plant feed if necessary
- Inspect the irrigation system to ensure it is operating correctly and efficiently
- Assess the overall health and appearance of the planting
- Identify any signs of plant stress, irrigation faults, or drainage issues

Horticultural Cutbacks

Planned horticultural maintenance visits are carried out throughout the year to manage plant growth and maintain the appearance and performance of the living wall.

- These visits are typically carried out by a team of two or three gardeners
- A Mobile Elevating Work Platform (MEWP) is used to safely access all areas of the living wall
- Plant species are pruned and maintained in line with their seasonal growth requirements
- Any weeds, dead foliage, or unwanted growth are removed
- General tidying and cleaning of the surrounding work area is completed during the visit
- Once maintenance is complete, all green waste is collected and removed from site
- Green waste is transported to a recycling facility for composting

Typical tools and equipment used include:

- Secateurs
- Leaf blower
- Sweeping brush
- Rubble bags
- Shovel
- MEWP equipment

End of Life

At the end of the system's service life, the living wall can be safely dismantled and removed using the following process:

- Mechanical access equipment, such as a Mobile Elevating Work Platform (MEWP), is used to safely access all installed areas of the living wall.
- The living wall modules are detached from the subframe and carefully removed.
- The soil substrate and plant material are removed from the modules and processed through composting or other suitable organic waste treatment methods.
- The modular units are removed and processed through the appropriate recycling or end-of-life waste stream.
- The irrigation dripline is removed and processed through the appropriate end-of-life waste or recycling route.
- The aluminium hanging rails and supporting subframe are dismantled and sent for recycling.
- The OBEX breathable membrane is removed and disposed of or recycled in accordance with the manufacturer's guidance and local waste regulations.
- The irrigation tank is removed and processed through the appropriate recycling or waste management route.
- Smaller irrigation components, including 16 mm fittings, elbows, tees, and end caps, are removed and separated for disposal or recycling where possible.
- Electrical and mechanical equipment, including the irrigation pump, dosing unit, and controller, are removed and processed in line with WEEE and other relevant waste management regulations.

This end-of-life scenario is based on the industry average scenario, in accordance with BRE 2025 PCR PN514 Rev. 3.2.; electrical and electronic components are assumed to be treated in accordance with UK WEEE regulations.

Life Cycle Assessment Calculation Rules

Declared / Functional unit description

100 m² ANS Living Wall system modelled with an aluminium top-hat subframe and planting media comprising peat, coir, and wood fibre (West+), with strawberry plants used as a proxy for ivy, over a 30-year study period, with a total system weight of 2,787.5 kg.

System boundary

The system boundary of the EPD is defined using the modular approach set out in EN 15804. This Cradle to Gate with Options EPD includes the product stage (A1-A3); transport to the construction site (A4); construction/installation (A5); the use stage modules, including use (B1), maintenance (B2), operational energy use (B6) and operational water use (B7); the end of life modules C1- C4 which includes demolition (C1); transport (C2), waste processing (C3) and//or disposal at end-of-life (C4) and benefits and loads beyond the system (D).

Modules A1–A3 include the upstream production of system components, including the manufacture of living wall modules, aluminium subframe, and the cultivation of plants at supplier locations (A1). Module A3 includes only the assembly and packaging of the system at the declared manufacturing site (Aldington Nurseries). A4 – include the transportation of the modules from Nursery to installation site, and A5 includes the assembly of the components at the installation site.

This EPD includes module B6 for operational energy use in accordance with EN 15804:2012+A2:2019 and follows the additional requirements of EN 50693 for products using energy and permanently installed in buildings or infrastructure, as defined by the manufacturer.

Data sources, quality and allocation

Specific primary data derived from Viritopia Limited production process has been modelled using BRE LINA A2 and the Ecoinvent 3.8 database. In accordance with the requirements of EN 15804:2012+A2:2019, the most current available data has been used. The manufacturer specific data from Viritopia Limited covers a period of one year (01/01/2023 – 31/12/2023).

The LCA study includes 100 m² of modular living wall system, with a total mass of 2,787.5 kg per unit.
The study represents a defined reference configuration of the modular living wall system based on a standard bill of materials and commercial specification.

The Viritopia modular living wall system accounts for the 100% of the site's total production. All Water consumption and production waste were allocated to the product using 100% mass allocation based on actual site data, in accordance with BRE 2025 PCR PN514 Rev 3.2 and EN 15804:2012+A2:2019. Raw materials, packaging outputs, and non-production waste were allocated based on actual usage figure.

The mass balance is within acceptable limits, with total outputs slightly higher than input materials by (-) 0.44%, which remains within the defined tolerance.

Where specific datasets were not available, appropriate proxy datasets were applied. In particular, Maintenance activities generate green waste from pruning and plant replacement. This waste is modelled as biowaste and directed to recycling/composting processes, using "biowaste to recycling (garden waste/home composting)" as a representative proxy.

Supplier-specific environmental data for key sub-components, including the aluminium top-hat subframe and polymer living wall module, were not available or could not be obtained within the study timeframe.

On-site processes are limited to assembly and packaging within module A3. Upstream processes, including the manufacture of system components and plant cultivation, are modelled using secondary datasets.

Secondary data has been obtained for all other upstream and downstream processes that are beyond the control of the manufacturer (i.e. raw material production) from the Ecoinvent 3.8 database. All Ecoinvent datasets are complete within the context used and conform to the system boundary and the criteria for the exclusion of inputs and outputs, according to the requirements specified in EN 15804:2012+A2:2019.

ISO14044 guidance. **Quality Level**	**Geographical representativeness**	**Technical representativeness**	**Time representativeness**
Very Good	Data from area under study.	Data from processes and products under study. Same state of technology applied as defined in goal and scope (i.e., identical technology).	There is less than 3 years between the Ecoinvent v3.8 (2021) LCI reference year, and the time-period for which the LCA was undertaken.

The quality level of geography, time and technological representativeness is Very Good as specific UK datasets have been selected from the ecoinvent LCI, and the background LCI datasets are from ecoinvent v3.8 which was compiled in 2021. Therefore, the most appropriate LCA data have been used. Location-based approach has been used for electricity in both modelling and results.

The GWP of the electricity dataset used for this EPD is: 1 kWh UK electricity = 2.39E-01 kgCO2eq (Electricity GB (kWh) market for electricity, medium voltage).

Data quality has been assessed in accordance with Table E.2 of EN 15804+A2, Annex E. The Life Cycle Assessment (LCA) has been carried out in accordance with EN 15804+A2, applying the cut-off approach as defined within the standard. Characterisation factors have been applied in line with Annex C (Table C.1) of EN 15804+A2.

Cut-off criteria

All raw material, packaging and energy inputs to the manufacturing process and waste have been included, except for direct emissions water, and soil, which are not measured.

Particular care was taken to ensure that environmentally relevant inputs associated with plant cultivation, substrate production, irrigation and structural components were fully included. Where applicable minor ancillary inputs such as, work gloves, disposable gloves, high viz vests etc were also included. Originally these had had been excluded, however we took the decision to include minor ancillary inputs.

No environmental processes associated with the production of the Living Wall system were intentionally excluded from the system boundary.

LCA Results

(MND = module not declared; MNR = module not relevant; INA = indicator not assessed; AGG = aggregated)

Parameters describing environmental impacts									
			GWP-total kg CO_2 eq	GWP-fossil kg CO_2 eq	GWP-biogenic kg CO_2 eq	GWP-luluc kg CO_2 eq	ODP kg CFC11 eq	AP mol H^+ eq	EP-freshwater kg $(PO_4)^{3-}$ eq
Product stage	Raw material supply	A1	1.01E+04	1.00E+04	1.30E+01	1.68E+01	1.57E-03	5.04E+01	2.90E+00
	Transport	A2	2.01E+02	2.00E+02	2.80E-01	9.24E-02	4.55E-05	9.28E-01	1.86E-02
	Manufacturing	A3	-9.75E+00	2.12E+02	-2.23E+02	3.90E-01	1.59E-05	6.84E-01	5.42E-02
	Total (Consumption grid)	A1-3	1.03E+04	1.04E+04	-2.10E+02	1.73E+01	1.63E-03	5.21E+01	2.97E+00
Construction process stage	Transport	A4	8.13E+01	8.11E+01	7.89E-02	2.92E-02	1.94E-05	3.39E-01	5.05E-03
	Construction	A5	1.47E+03	1.46E+03	2.32E+02	1.95E+00	2.42E-03	8.97E+00	1.41E+00
Use stage (30 years)	Use	B1	-7.26E+03	0.00E+00	-7.26E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	4.30E+06	3.88E+06	4.14E+05	3.40E+03	5.57E-01	3.03E+04	4.48E+02
	Operational energy use	B6	6.09E+02	6.02E+02	5.48E+00	6.33E-01	4.59E-05	1.34E+00	8.24E-02
	Operational water use	B7	3.59E+02	3.51E+02	7.14E+00	6.10E-01	2.35E-05	1.96E+00	2.54E-01
End of life	Deconstruction, demolition	C1	1.29E+02	1.29E+02	2.45E-01	8.99E-03	1.79E-05	8.77E-01	2.77E-03
	Transport	C2	9.28E+00	9.27E+00	7.90E-03	3.64E-03	2.14E-06	3.76E-02	5.97E-04
	Waste processing	C3	3.07E+02	2.91E+02	1.60E+01	2.93E-03	8.65E-07	1.13E-01	1.10E-03
	Disposal	C4	7.36E+03	9.88E+01	7.26E+03	1.27E-01	6.75E-06	4.35E-01	2.70E-02
Potential benefits and loads beyond the system boundaries	Reuse, recovery, recycling potential	D	-6.15E+03	-6.16E+03	1.79E+01	-8.21E+00	-1.82E-04	-3.94E+01	-1.84E+00

GWP-total = Global warming potential, total;
GWP-fossil = Global warming potential, fossil;
GWP-biogenic = Global warming potential, biogenic;
GWP-luluc = Global warming potential, land use and land use change;

ODP = Depletion potential of the stratospheric ozone layer;
AP = Acidification potential, accumulated exceedance; and
EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment

LCA Results (continued)

(MND = module not declared; MNR = module not relevant; INA = indicator not assessed; AGG = aggregated)

Parameters describing environmental impacts									
			EP-marine	EP-terrestrial	POCP	ADP-mineral& metals	ADP-fossil	WDP	PM
			kg N eq	mol N eq	kg NMVOC eq	kg Sb eq	MJ, net calorific value	m^3 world eq deprived	disease incidence
Product stage	Raw material supply	A1	8.14E+00	1.18E+02	2.86E+01	1.26E-01	1.80E+05	4.84E+03	7.58E-04
	Transport	A2	2.82E-01	3.08E+00	9.89E-01	1.39E-03	3.05E+03	1.71E+01	2.16E-05
	Manufacturing	A3	2.97E-01	2.02E+00	6.09E-01	1.33E-03	4.21E+03	2.53E+03	1.01E-05
	Total (Consumption grid)	A1-3	8.72E+00	1.23E+02	3.02E+01	1.29E-01	1.87E+05	7.39E+03	7.89E-04
Construction process stage	Transport	A4	1.03E-01	1.13E+00	3.63E-01	1.86E-04	1.26E+03	6.11E+00	9.54E-06
	Construction	A5	2.01E+00	2.11E+01	5.78E+00	3.57E-01	1.87E+04	5.19E+02	9.06E-05
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	1.01E+04	1.26E+05	3.03E+04	3.13E+01	5.06E+07	9.80E+05	6.24E-01
	Operational energy use	B6	4.01E-01	4.46E+00	1.09E+00	3.75E-03	1.60E+04	3.67E+01	9.28E-06
	Operational water use	B7	3.78E-01	3.59E+00	1.17E+00	1.74E-03	6.05E+03	4.60E+04	1.89E-05
End of life	Deconstruction, demolition	C1	3.90E-01	4.26E+00	1.17E+00	4.79E-05	1.16E+03	5.53E+00	2.33E-05
	Transport	C2	1.13E-02	1.24E-01	3.79E-02	3.22E-05	1.40E+02	6.30E-01	8.00E-07
	Waste processing	C3	7.15E-02	5.47E-01	1.32E-01	2.63E-05	7.96E+01	1.86E+01	4.85E-07
	Disposal	C4	8.04E-02	8.49E-01	2.51E-01	3.97E-03	7.94E+02	1.88E+01	6.84E-06
Potential benefits and loads beyond the system boundaries	Reuse, recovery, recycling potential	D	-6.59E+00	-6.88E+01	-1.97E+01	-5.31E-03	-5.54E+04	-7.34E+02	-5.08E-04

EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment;
EP-terrestrial = Eutrophication potential, accumulated exceedance;
POCP = Formation potential of tropospheric ozone;
ADP-mineral&metals = Abiotic depletion potential for non-fossil resources;
ADP-fossil = Depletion potential of the stratospheric ozone layer;
WDP = Water (user) deprivation potential, deprivation-weighted water consumption; and
PM = Particulate matter.

LCA Results (continued)

(MND = module not declared; MNR = module not relevant; INA = indicator not assessed; AGG = aggregated)

Parameters describing environmental impacts							
			IRP	ETP-fw	HTP-c	HTP-nc	SQP
			kBq U^{235} eq	CTUe	CTUh	CTUh	dimensionless
Product stage	Raw material supply	A1	1.03E+03	9.81E+05	8.67E-06	1.62E-04	8.03E+04
	Transport	A2	1.68E+01	2.61E+03	1.59E-07	3.04E-06	2.51E+03
	Manufacturing	A3	1.16E+02	5.25E+03	5.42E-07	3.84E-06	2.14E+04
	Total (Consumption grid)	A1-3	1.16E+03	9.89E+05	9.37E-06	1.69E-04	1.04E+05
Construction process stage	Transport	A4	6.40E+00	9.88E+02	2.73E-08	1.08E-06	1.45E+03
	Construction	A5	1.63E+02	9.16E+04	3.78E-06	4.73E-05	5.67E+03
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	2.17E+05	4.88E+08	1.85E-03	4.50E-02	1.99E+07
	Operational energy use	B6	5.29E+02	6.94E+03	1.96E-07	4.62E-06	5.97E+03
	Operational water use	B7	1.26E+02	6.39E+03	1.48E-06	2.08E-05	1.37E+03
End of life	Deconstruction, demolition	C1	5.36E+00	7.68E+02	3.00E-08	6.42E-07	1.51E+02
	Transport	C2	7.20E-01	1.09E+02	3.54E-09	1.15E-07	9.62E+01
	Waste processing	C3	1.97E-01	6.13E+02	2.62E-08	9.63E-07	2.15E+01
	Disposal	C4	7.23E+00	9.50E+04	6.85E-08	2.75E-06	7.30E+02
Potential benefits and loads beyond the system boundaries	Reuse, recovery, recycling potential	D	-7.47E+01	-1.58E+05	-6.35E-06	-1.35E-04	-1.15E+04

IRP = Potential human exposure efficiency relative to U235;
ETP-fw = Potential comparative toxic unit for ecosystems;
HTP-c = Potential comparative toxic unit for humans;
HTP-nc = Potential comparative toxic unit for humans; and
SQP = Potential soil quality index.

LCA Results (continued)

(MND = module not declared; MNR = module not relevant; INA = indicator not assessed; AGG = aggregated)

Parameters describing resource use, primary energy

			PERE	PERM	PERT	PENRE	PENRM	PENRT
			MJ	MJ	MJ	MJ	MJ	MJ
Product stage	Raw material supply	A1	9.88E+03	0.00E+00	9.88E+03	1.21E+05	4.12E+04	1.63E+05
	Transport	A2	5.48E+01	0.00E+00	5.48E+01	3.00E+03	0.00E+00	3.00E+03
	Manufacturing	A3	2.38E+03	2.18E+03	4.56E+03	4.70E+03	4.76E+02	5.17E+03
	Total (Consumption grid)	A1-3	1.23E+04	2.18E+03	1.45E+04	1.29E+05	4.17E+04	1.71E+05
Construction process stage	Transport	A4	1.61E+01	0.00E+00	1.61E+01	1.24E+03	0.00E+00	1.24E+03
	Construction	A5	1.59E+03	2.98E+02	1.88E+03	1.83E+04	8.92E+02	1.92E+04
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	5.41E+06	-4.08E+06	1.34E+06	4.67E+07	1.14E+06	4.78E+07
	Operational energy use	B6	3.84E+03	0.00E+00	3.84E+03	2.11E+04	0.00E+00	2.11E+04
	Operational water use	B7	8.31E+02	0.00E+00	8.31E+02	6.08E+03	0.00E+00	6.08E+03
End of life	Deconstruction, demolition	C1	6.15E+00	1.77E+00	7.92E+00	5.50E+02	5.86E+02	1.14E+03
	Transport	C2	1.97E+00	0.00E+00	1.97E+00	1.38E+02	0.00E+00	1.38E+02
	Waste processing	C3	-2.52E+02	2.54E+02	2.49E+00	-3.51E+03	3.59E+03	7.92E+01
	Disposal	C4	-4.49E+02	5.15E+02	6.56E+01	4.96E+02	0.00E+00	4.96E+02
Potential benefits and loads beyond the system boundaries	Reuse, recovery, recycling potential	D	-3.39E+03	0.00E+00	-3.39E+03	-5.50E+04	0.00E+00	-5.50E+04

PERE = Use of renewable primary energy excluding renewable primary energy 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 resource

LCA Results (continued)

(MND = module not declared; MNR = module not relevant; INA = indicator not assessed; AGG = aggregated)

Parameters describing resource use, secondary materials and fuels, use of water						
			SM	RSF	NRSF	FW
			kg	MJ net calorific value	MJ net calorific value	m^3
Product stage	Raw material supply	A1	4.76E+02	0.00E+00	0.00E+00	1.17E+02
	Transport	A2	0.00E+00	0.00E+00	0.00E+00	4.24E-01
	Manufacturing	A3	1.02E+01	2.69E-03	0.00E+00	5.95E+01
	Total (Consumption grid)	A1-3	4.86E+02	2.69E-03	0.00E+00	1.77E+02
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	1.50E-01
	Construction	A5	1.63E+01	4.51E-06	0.00E+00	1.32E+01
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	7.07E+04	0.00E+00	0.00E+00	2.33E+04
	Operational energy use	B6	1.80E+00	1.39E-02	0.00E+00	3.50E+00
	Operational water use	B7	2.17E+01	0.00E+00	0.00E+00	1.07E+03
End of life	Deconstruction, demolition	C1	4.33E-01	4.51E-06	0.00E+00	1.34E-01
	Transport	C2	0.00E+00	0.00E+00	0.00E+00	1.56E-02
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	4.35E-01
	Disposal	C4	0.00E+00	0.00E+00	0.00E+00	4.63E-01
Potential benefits and loads beyond the system boundaries	Reuse, recovery, recycling potential	D	0.00E+00	0.00E+00	0.00E+00	-1.97E+01

SM = Use of secondary material;
RSF = Use of renewable secondary fuels;
NRSF = Use of non-renewable secondary fuels;
FW = Net use of fresh water

LCA Results (continued)

(MND = module not declared; MNR = module not relevant; INA = indicator not assessed; AGG = aggregated)

Other environmental information describing waste categories					
			HWD	NHWD	RWD
			kg	kg	kg
Product stage	Raw material supply	A1	4.20E+03	1.17E+04	2.51E-01
	Transport	A2	4.33E+00	8.23E+01	2.05E-02
	Manufacturing	A3	1.44E+01	2.33E+02	3.13E-02
	Total (Consumption grid)	A1-3	4.22E+03	1.20E+04	3.02E-01
Construction process stage	Transport	A4	1.33E+00	2.32E+01	8.57E-03
	Construction	A5	2.11E+02	2.70E+03	5.87E-02
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	1.15E+06	1.68E+06	2.31E+02
	Operational energy use	B6	2.15E+01	3.71E+02	1.37E-01
	Operational water use	B7	4.17E+01	1.22E+03	3.61E-02
End of life	Deconstruction, demolition	C1	2.20E+00	3.08E+01	7.95E-03
	Transport	C2	1.54E-01	2.74E+00	9.48E-04
	Waste processing	C3	4.89E+00	1.42E+02	1.41E-04
	Disposal	C4	8.76E+00	3.13E+02	1.98E-03
Potential benefits and loads beyond the system boundaries	Reuse, recovery, recycling potential	D	-1.22E+03	-7.65E+03	-6.37E-02

HWD = Hazardous waste disposed;
NHWD = Non-hazardous waste disposed;
RWD = Radioactive waste disposed

LCA Results (continued)

(MND = module not declared; MNR = module not relevant; INA = indicator not assessed; AGG = aggregated)

Other environmental information describing output flows – at end of life								
			CRU	MFR	MER	EE	Biogenic carbon (product)	Biogenic carbon (packaging)
			kg	kg	kg	MJ per energy carrier	kg C	kg C
Product stage	Raw material supply	A1	0.00E+00	6.48E-01	1.21E-03	0.00E+00	3.48E+01	0.00E+00
	Transport	A2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Manufacturing	A3	0.00E+00	4.66E-02	1.99E-05	2.14E+00	0.00E+00	6.86E+01
	Total (Consumption grid)	A1-3	0.00E+00	6.95E-01	1.23E-03	2.14E+00	0.00E+00	6.86E+01
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Construction	A5	0.00E+00	4.12E+01	7.62E-07	3.60E-03	0.00E+00	0.00E+00
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	2.41E-01	1.03E-04	1.11E+01	0.00E+00	0.00E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction, demolition	C1	0.00E+00	7.82E-05	1.90E+01	3.60E-03	0.00E+00	0.00E+00
	Transport	C2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Waste processing	C3	0.00E+00	0.00E+00	1.16E+02	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potential benefits and loads beyond the system boundaries	Reuse, recovery, recycling potential	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

CRU = Components for reuse;
MFR = Materials for recycling

MER = Materials for energy recovery;
EE = Exported Energy

Scenarios and additional technical information

Scenarios and additional technical information			
Scenario	Parameter	Units	Results
A4 – Transport to the building site	Transport to site is based on project-specific delivery data over a 12-month period. A total of 26 projects were completed, with a cumulative transport distance of 8,340 km. This corresponds to an average transport distance of approximately 320.8 km per project		
	Lorry > 32 tonne	Litre of fuel type per distance or vehicle type	0.227
	Distance:	km	320.79
A5 – Installation in the building	Installation of the modular living wall system is carried out using mechanical access equipment (e.g. MEWP) to access all required areas. Vertical aluminium top-hat battens are fixed to the installation surface at approximately 600 mm centres, followed by the installation of a breathable membrane to the subframe. Aluminium hanging rails are then mounted horizontally onto the battens at regular vertical intervals. Modular planting units are installed sequentially from the base upwards and secured to the hanging rails. An irrigation dripline is installed across each row of modules and connected to a central irrigation system, including tank, pump, controller and dosing unit located within a plantroom. A drainage gutter is installed at the base of the system and connected to the site drainage network. Installation is completed with system testing and commissioning. A range of ancillary components are required during installation, including polymer fittings, clips, couplings, cable ties and fixing accessories. In accordance with BRE PCR PN 514 Rev 3.2, these items are grouped by material type and modelled using aggregated mass assumptions. The total mass of polymer ancillary components is assumed to be 19 kg per declared unit, and metal fixing components are assumed to be 22 kg per declared unit. Energy use during installation is associated with the operation of mechanical access equipment (e.g. MEWP). Diesel consumption is estimated at 24-25 litres per declared unit (100 m² installation), based on typical usage of approximately 3 litres per hour over an 8-hour installation period. This is equivalent to approximately 248 kWh of energy. Additional electricity use for handheld tools (e.g. electric drills) is estimated at 0.825 kWh per declared unit. Wooden pallets used for the delivery of ancillary components are assumed to be returned for reuse. Wooden pallets associated with components delivered at A3 are accounted for in Module A5 as wood waste directed to recycling.		
	Wooden chocks to recycling	kg	21.11
	Wooden Euro Pallets	kg	175
B1 – Use	During the use stage, the Green Living Wall system functions as a vertical vegetated system installed on the exterior or interior of a building, providing aesthetic, environmental, and thermal benefits. Following installation, the system enters its operational phase, during which it performs its intended functions and is subject to routine maintenance. The system may contribute to improved air quality, passive cooling, noise attenuation, and enhanced biodiversity. For exterior applications, additional benefits may include façade shading and mitigation of the urban heat island effect. For interior installations, the system may contribute to improved indoor air quality and occupant wellbeing. Biogenic carbon uptake associated with plant growth (CO_2 sequestration) occurs during the use stage and is considered over the 30-year reference service life (RSL), where applicable.		

Scenarios and additional technical information			
Scenario	Parameter	Units	Results
	Co2 sequestration for 30 years	kg	-7260
B2 – Maintenance	Maintenance of the modular living wall system includes routine horticultural activities to ensure plant health and system performance. This typically comprises approximately 10 health check visits and 2 horticultural pruning visits per annum. Maintenance activities include pruning, replanting, pest and disease control, and seasonal plant replacement. Over the 30-year reference service life (RSL), the total mass of ancillary components required for maintenance is estimated at 1,196 kg per declared unit Energy use during maintenance is associated with the operation of mechanical access equipment. Fuel consumption is estimated at approximately 50 litres of diesel per year (based on two maintenance periods), equivalent to 496 kWh per year. Over the 30-year RSL, this corresponds to a total energy use of 14,880 kWh. Maintenance activities generate green waste from pruning and plant replacement. This waste is modelled as biowaste and directed to recycling/composting processes, using “biowaste to recycling (garden waste/home composting)” as a representative proxy.		
	Biowaste to Recycling	kg	2640
B6 – Use of energy	Operational energy use is associated with the irrigation pump required to support plant growth within the living wall system. The irrigation pump is assumed to operate for approximately 20 minutes per day over 300 days per year. The pump is modelled based on an 850 W motor, resulting in a total electricity consumption of approximately 2,550 kWh over the 30-year reference service life (RSL).		
	Irrigation Pump Electricity	Kwh	2550
B7 – Use of water	The living wall system is irrigated using an integrated irrigation system. The system is assumed to operate for approximately 5 minutes per day over 296 days per year. Water consumption is estimated at 0.24 litres per minute per m² of living wall. For a declared unit of 100 m², this corresponds to an annual water consumption of approximately 35,520 litres (35.52 m³). Over the 30-year reference service life (RSL), this equates to a total water consumption of approximately 1,066,000 litres (1066 m³)		
	Water	m3	1066

Scenarios and additional technical information			
Scenario	Parameter	Units	Results
C1 – Deconstruction	The modular living wall system is deconstructed as part of building refurbishment, façade replacement, or demolition activities. The process involves the disassembly and removal of all system components, including the supporting framework, irrigation infrastructure, planting modules, and associated vegetation. Disassembly is carried out using a combination of manual labour and small powered tools (e.g. drills and hand tools), with powered access equipment (e.g. MEWP) used where the system is installed at height. Due to the modular design of the system, no heavy demolition equipment is required Energy use during deconstruction is associated with access equipment and handheld tools. Fuel consumption for access equipment is estimated at approximately 25 litres per declared unit (100 m²), equivalent to 248 kWh. Electricity use for handheld tools is estimated at 0.8256 kWh per declared unit, based on the removal of approximately 344 fixings per 100 m². Labour is the primary input to the deconstruction process, with relatively low energy demand compared to conventional demolition activities. The energy requirements are assumed to be comparable to those during installation During deconstruction, the living wall system is fully removed from the site and transported to a waste processing facility. Materials associated with installation in Module A5 that remain with the product are separated and classified as deconstruction waste within Module C1 (e.g. plastic, metal, electronic and general waste). It is assumed that 100% of the product is recovered from the demolition site. This end-of-life scenario is based on an industry-average approach in accordance with BRE PCR PN 514 Rev 3.2. Electrical and electronic components are assumed to be treated in accordance with UK WEEE regulations		
C2 Transport	Transport to waste processing - 100% returned from building installation to waste disposal site. Assumed all buildings will be in cities & towns and will be a maximum of 20 km from waste disposal facility.		
	Distance – Road transport	km	20

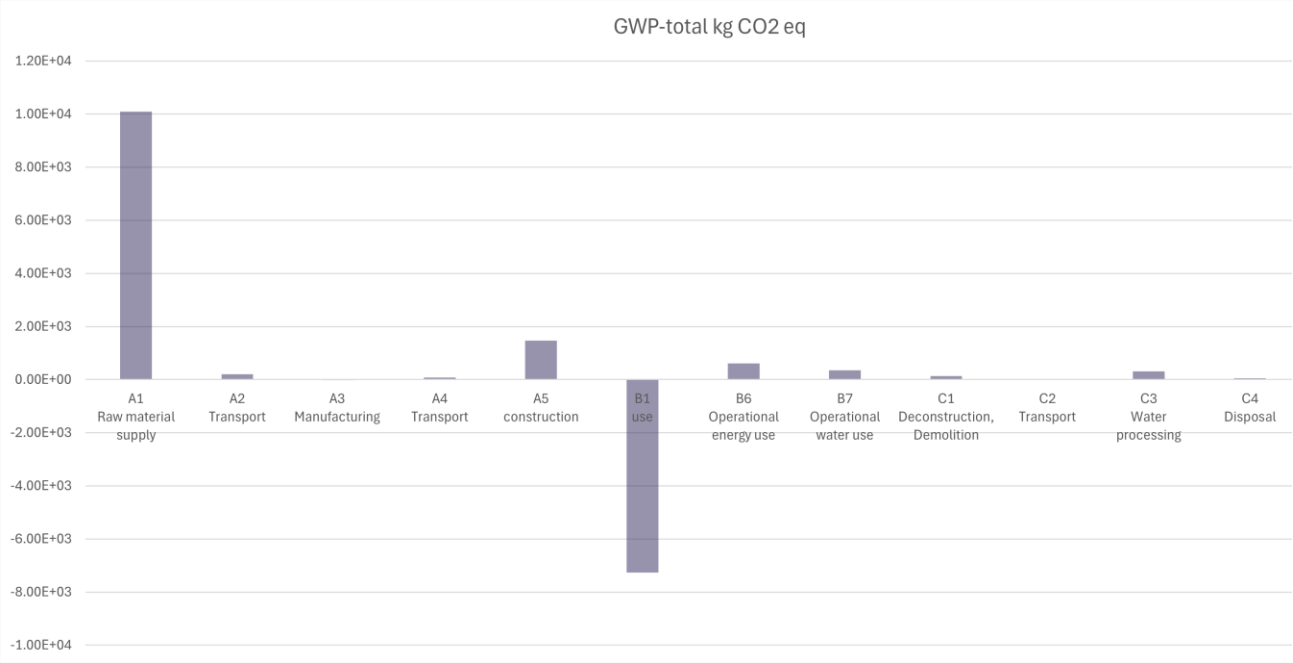
Scenarios and additional technical information			
Scenario	Parameter	Units	Results
C3 – Waste Processing	Following deconstruction, the components of the living wall are separated into defined material streams. No pre-processing activities are undertaken before the product is sent to recycling centres. This stage considers the default end-of-life scenarios for aluminium, electronic components, plastics, and organic matter. For all types of aluminium, the end-of-life scenario stated in BRE's PCR 3.2 is applied, whereby 95% of the material is assumed to be recycled and 5% sent to landfill. Using the same recycling assumption, the quantity of aluminium available for recycling is calculated as 368.6 kg (398 kg × 0.95). For electronics, the end-of-life scenario stated in UKWEEE is applied, whereby 55% of the material is assumed to be recycled and 45% sent to landfill. Using the same recycling assumption, the quantity of electronics available for recycling is calculated as 0.77 kg (1.4 kg × 0.55). The BRE PCR does not specify an end-of-life scenario for biowaste. Therefore, organic matter (strawberry plants) and substrate is modelled as Biowaste (Plant and substrate) waste to landfill. Waste treatment processes are modelled using ecoinvent v3.8 dataset, "treatment of garden biowaste, home composting in heaps RoW" with 100% of the material assumed to be landfilled. For plastics, the primary living wall modules (880 kg) are returned to Viritopia for reuse. The remaining plastic components (116.45 kg) are sent for 100% incineration in accordance with the end-of-life scenario stated in BRE's PCR 3.2. For fabrics (capillary matting), the end-of-life scenario from the BRE PCR that most closely matches is Floor finish (underlay), textile (recycled). Under this scenario, 100% of the material is assumed to be sent to incineration with energy recovery Based on this assumption, the quantity of fabric available for incineration is calculated as 17.6 kg (17.6 kg × 100%).		
	Aluminium waste to recycling	kg	368.6
	Electronic waste to recycling	kg	0.77
	Plastics waste to recycling	kg	880
	Plastics waste to incineration	kg	116.45
	Fabrics waste to incineration	kg	17.6
C4- Disposal	For aluminium, according to Appendix D of the BRE PCR EN15804+A2 default end-of-life scenario, 5% of all aluminium is assumed to be sent to landfill. The total mass of aluminium sent to landfill is therefore calculated as 19.4 kg (388 kg × 5%). For electronic components, the end-of-life scenario defined by UK WEEE is applied, under which 45% of electronic waste is assumed to be sent to landfill. The total mass sent to landfill is calculated as 0.63kg (1.4 kg × 0.45). For organic matter (strawberry plants) and Substrate, the BRE PCR 3.2 does not specify an end-of-life scenario. Hence, according to the ecoinvent v3.8 dataset "treatment of garden biowaste, home composting in heaps RoW" 100% of the material is assumed to be landfilled. The total mass of organic matter (strawberry plants) sent to landfill is therefore calculated as 120 kg (120 kg × 100%) and the total mass of Substrate sent to landfill is therefore calculated as 1,264 kg (1,264 kg × 100%). All the sequestered carbon in A1-A3 and in B1 will be released to the atmosphere once the organic and substrate waste are landfilled		

Scenarios and additional technical information			
Scenario	Parameter	Units	Results
	Aluminium waste to landfill	kg	19.4
	Electronic waste to landfill	kg	0.63
	organic matter waste to landfill	kg	120
	Substrate waste to landfill	kg	1264
Module D	"Benefits and loads beyond the system boundary" (Module D) accounts for the potential environmental benefits and loads associated with Waste streams comprising aluminium, electronic components, plastics, and organic matter collected for recycling and incineration with energy recovery at end of life The benefits and loads associated with Aluminium recycling are calculated by excluding the pre-existing recycled content. Of the 368.6 kg of recovered aluminium, recycled at end of life, the material is assumed to consist of 25.9% recycled content and 74.1% virgin material, based on the secondary material (SM) indicator for aluminium using the background ecoinvent 3.8 dataset "Aluminium alloy production Europe". Accordingly, only the primary (virgin) aluminium content is considered when calculating Module D benefits as 273.13 kg (74.1% of 368.6 kg). For electronic components, Module D benefits are calculated based on end-of-life recycling rates in accordance with UK WEEE assumptions, without adjustment for pre-existing recycled content as they do not have a single SM. Hence, the recycling mass is considered as such in Module D when calculating benefits. In addition, the benefits of Module D include the energy credits from incineration of plastic (116.45 kg) & Fabrics (capillary matting :17.6kg) at end-of-life are accounted for in Module D energy recovery calculation. Recovered energy is assumed to substitute the average regional electricity and/or heat mix. It is assumed that the plastic will be incinerated in the UK, so the UK electricity dataset has been selected. The dataset used to calculate the avoided impacts of electricity consumption in a future system was 'Electricity, medium voltage {GB}| market for | Alloc Def, U'. This process is energy-efficient, with 37.4% of the combustion heat recovered after incineration. The efficiency rate of 37.4% has been calculated by taking the weighted average of the number of waste incineration plants available in the UK. According to the Environmental Agency's 2013 article on "CHP Ready Guidance for Combustion and Energy from Waste Power Plants" in the UK, EFW plants have an efficiency of 33%, and CHP plants have an efficiency of 55%. Additionally, according to Azapagic, A., & Jeswani, H. K. (2016), there are currently 25 MSW incinerators with energy recovery in the UK. It is assumed that 20 plants generate heat and power at 33%, while 5 plants generate electricity at 55%. Therefore, a weighted average calculation is used to determine the efficiency, which is calculated at 37.5%.		
	Aluminium- Recycled Content (post-consumer)	kg	95.46
	Aluminium Recovered for recycling	kg	368.6
	Benefits of recycling Aluminium	kg	273.13
	Benefits of recycling Electronics	kg	0.77
	Recovered for energy (plastics)	kg	116.45
	Recovered for energy (fabrics)	kg	17.6

Interpretation

From the product life cycle stages A1–C4, the maintenance stage (B2) results in the highest environmental impacts due to the intensive maintenance requirements of the living wall system. The living wall requires maintenance activities multiple times per year, and with an estimated service life of 30 years, this results in a significant number of maintenance interventions over the assessment period. Consequently, the cumulative impacts associated with maintenance activities dominate the overall product system life cycle impacts. For clarity of interpretation, the B2 module has been excluded from the graph and the carbon sequestration and release has been shown in the below graph.

The chart – 1 has been assessed for the modules A1-A3, A4-A4, B1, B6, B7, and C1-C4 which indicates that the majority of the remaining environmental impact arises from the raw material stage, with additional contributions from construction activities and end-of-life disposal. The negative impact shown in module B1 represents temporary biogenic carbon sequestration during the use phase, where carbon is stored within the product. However, as this stored carbon is assumed to be released at the end of life, the benefit is offset by emissions in the disposal stage. Therefore, the sequestration effect should be interpreted as temporary carbon storage rather than a permanent reduction in atmospheric carbon.



GWP total Figure 1

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