Environmental Product Declaration

In accordance with ISO 14025 and EN 15804:2012+A2:2019 for:

Plastic ducting products

from

TufDuct

Programme:	EPD Australasia, www.epd-australasia.com/
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An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com

Contents

1. General information

1.1. Programme information

Programme:	EPD Australasia
Address:	315a Hardy Street Nelson 7010 New Zealand.
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CEN standard EN 15804 serves as the Core Product Category Rules (PCR)
Product category rules (PCR): Product Category Rules (PCR) 2019:14, v1.1 – Construction products
PCR review was conducted by: The Technical Committee of the International EPD® System. Chair: Claudia A. Peña. Contact via info@environdec.com
Geographical scope: Australia and New Zealand.
Independent third-party verification of the declaration and data, according to ISO 14025:2006: ☐ EPD process certification ☒ EPD verification
Third party verifier: Kimberly Robertson Catalyst, PO Box 214, Katikati 3166, NZ. www.catalystnz.co.nz Verifier approved by EPD Australasia
Procedure for follow-up of data during EPD validity involves third party verifier: ☐ Yes ☒ No

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but from different programmers may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804. For further information about comparability, see EN 15804 and ISO 14025.

2. Company information

2.1. Owner of the EPD

TufDuct Pty Ltd.
8 Harris Street (PO Box 151) Port Kembla 2505 NSW AUSTRALIA

2.2. Contact

David Maher – dave@tufduct.com.au
Director
TufDuct Pty Ltd. – www.tufduct.com.au

2.3. Description of the organisation

TufDuct's team includes personnel from electrical, chemical, and mechanical engineering backgrounds. We understand your services protection requirements and have extensive experience in the field.
TufDuct has worked with many different traditional methods for getting services around sites and have experience solving most issues which are typically faced in an install. Our ducting products solve and eradicate many of these problems. Furthermore, these products are made from 100% recycled polyethylene, are safe to store, and can easily be carried and installed by one person. Our vision is for TufDuct to be known as a sustainable, low-cost provider of a diverse range of ducting solutions.

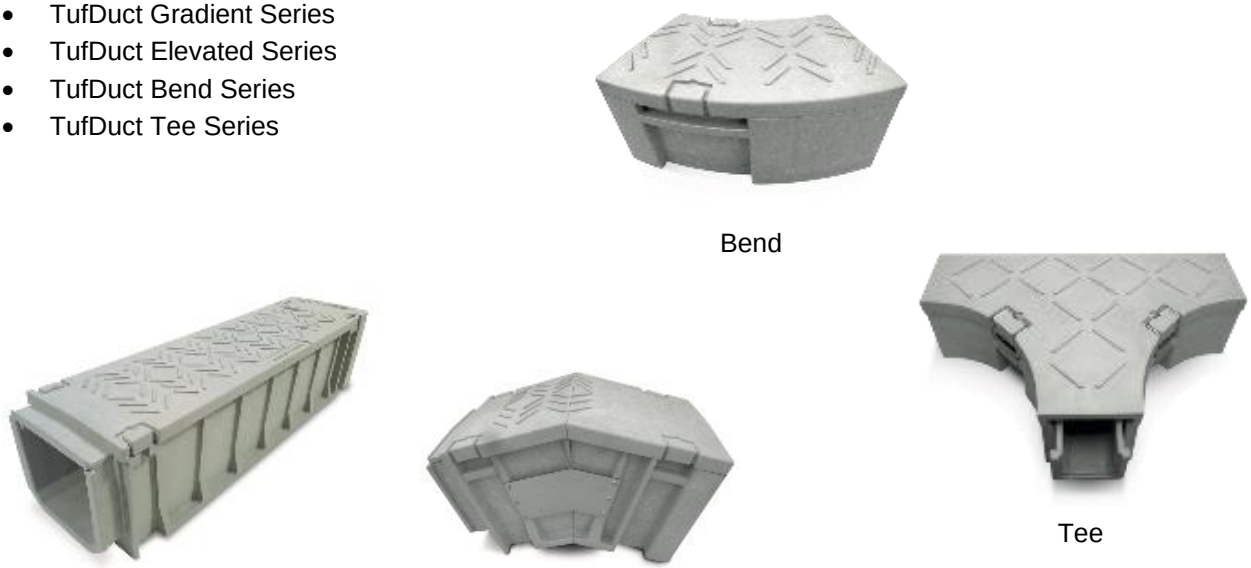
2.4. Name and location of production site(s)

All TufDuct products assessed in this EPD are manufactured at one plant located in Ichihara, Chiba, Japan

3. Product information

3.1. Product name

- TufDuct Straight Series
- TufDuct Gradient Series
- TufDuct Elevated Series
- TufDuct Bend Series
- TufDuct Tee Series



Bend

Tee

Straight/Gradient/ Elevated

Figure 1: TufDuct product images

3.2. Product identification
Plastic ducts made from 100% recycled polyethylene

3.3. Product description
TufDuct's ducting products are made from 100% recycled polyethylene and are used for housing services including high voltage electrical cables, data cables, etc. for trains, buildings, tunnels, and other infrastructure applications.

They are engineered and manufactured in Japan with a design life of 50 years. The products are halogen free and resistant to hydrochloric acid, seawater, ice melting agents, acid rain and many other corrosive substances. They are tested for drop, torsion and external pressures with and without lid on. These products are commonly installed in tunnels and enclosed area due to their flame-resistant properties and protects services in bushfire prone areas. They are also suitable for high-voltage applications with 180 kV normal insulation properties. The products can handle a large range of temperature (-30 °C to 80 °C). This EPD coveres five types of ducting series with six sizes per series. In general, the composition of all of the ducts is: ~65% recycled PE pellet, ~15% filler, ~20% additives (flame retardants etc.) and <1% steel bolts

3.4. UN CPC code
The UN CPC code for TufDuct products covered by this EPD is 36320

4. LCA information
4.1. Declared unit
- The declared unit for straight, elevated and gradient series of ducts is 1 m of ducts which fulfil the specified quality criteria during the Reference Service Life of 50 years which fullfills.

- The declared unit for bend and tee series of ducts is 1 kg of ducts which fufil the specified quality criteria during the Reference Service Life of 50 years which fullfills.

Straight ducts are designed to be used on the flat surface while elevated ducts are designed to be used in flat configuration ducting at elevation. Gradient ducts are designed to be used in gradient up and down configurations. In real application, these ducts (straight, elevated and gradient) are measured in length and therefore, the declared unit for straight, elevated and gradient ducts is chosen to be in meters. The bend and tee, in contrast, are used as connectors for straight, elevated and gradient ducts and as such are procured/ used on per piece basis rather than per m. For this purpose, a declared unit of 'per kg' is ideal to represent the environmental and other impacts of the bend and tee series.

4.2. Time representativeness
Foreground data on raw material requirements, manufacture, construction, use and end of life inputs and outputs was provided first-hand by TufDuct for FY19/20 (01 Jul 2019 to 30 Jun 2020)

4.3. Database(s) and LCA software used
The inventory data for the process are entered into the SimaPro (v9.1.1.1) LCA software program and linked to the pre-existing data for the upstream feedstocks and services selected in order of preference from:

- For Australia, the Australian Life Cycle Inventory (AusLCI) v1.31 compiled by the Australian Life Cycle Assessment Society (AusLCI, 2019) and the Australasian Unit Process LCI v2014.09. The AusLCI database at the time of this report was 2 years old, while the Australasian Unit Process LCI was 6 years old.

- Other authoritative sources (e.g., Ecoinvent v3.6, 2019), where necessary adapted for relevance to Australian conditions (energy sources, transport distances and modes and so on, and documented to show how the data is adapted for national relevance). At the time of reporting, the Ecoinvent v3.6 database was 2 years old.

4.4. Description of system boundaries

The LCA scope of this EPD is cradle to gate with options, modules C1–C4, module D and with optional modules (A1–A3 + C + D and additional modules). The geographical scope of this EPD is Australia and New Zealand.

Table 1 – Life Cycle of building products: stages and modules included in this EPD

GPI Module		Asset life cycle stage	Information module	Declared modules	Geography	Specific data	Variation - Products	Variation - sites
Upstream	A1	Raw material supply	A1-3. Manufacturing stage	X	Japan	>90%	<10%	Not applicable
Core	A2	Transport		X	Japan			
	A3	Manufacturing		X	Japan			
Downstream	A4	Transport	A4-5. Construction stage	X	Japan/AU/ NZ	>90%	-	
	A5	Construction, installation process		X	AU/NZ	-	-	
	B1	Material emissions from usage	B. Usage stage	MND		-	-	
	B2	Maintenance		MND		-	-	
	B3	Repair		MND		-	-	
	B4	Replacement		MND		-	-	
	B5	Refurbishment		MND		-	-	
	B6	Operational energy use		MND		-	-	
	B7	Operational water use		MND		-	-	
	C1	Deconstruction and demolition	C. End of life	X	AU/NZ	-	-	
	C2	Transport		X	AU/NZ	-	-	
	C3	Waste processing		X	AU/NZ	-	-	
	C4	Disposal		X	AU/NZ	-	-	
Other environmental information	D	Reuse, recycle or recovery	D. Recyclability potentials	X	AU/NZ	-	-	

MND=Module not declared (such a declartion shall not be ragarded as an indicator of zero result)

The following life cycle stages have not been declared, as they are deemed not applicable for TufDuct Duct Ranges: Material emissions from usage (B1); Maintenance (B2); Repair (B3); Replacement (B4); Refurbishment (B5), Operational energy use (B6) and Operational water use (B7).

4.5. System diagram:

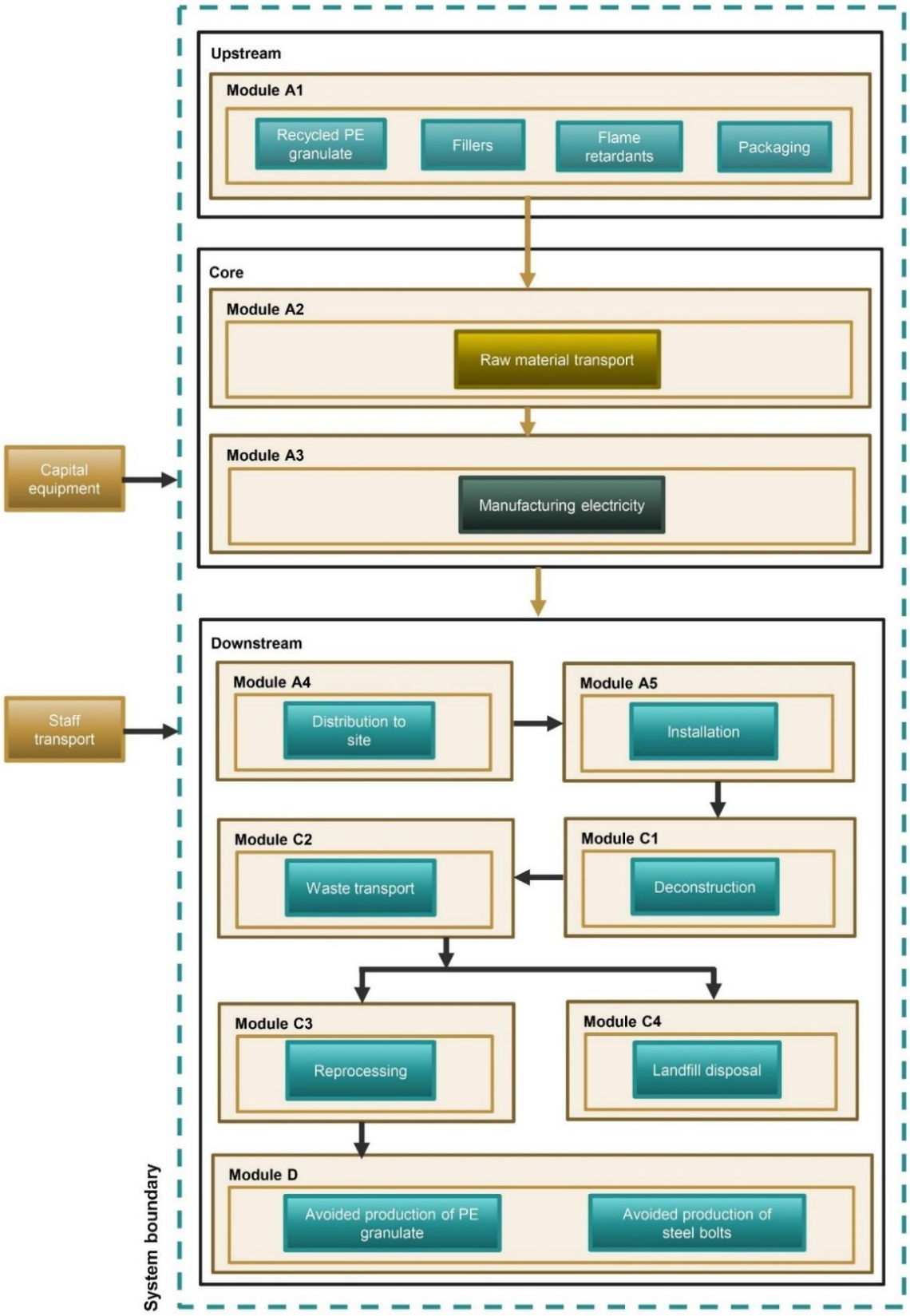


Figure 2: TufDuct EPD system boundary

Upstream processes

The upstream processes include those involved in Module A1 – Raw material supply. This module includes:

- Extraction, transport and manufacturing of raw materials.
- Generation of electricity from primary and secondary energy resources, also including their extraction, refining and transport for Modules A1 and A3.
- Processing up to the end-of-waste state or disposal of final residues including any packaging not leaving the factory gate with the product

Core Processes

The core processes include those involved in Module A2 and Module A3, including:

- External transportation of materials to the core processes and internal transport.
- Manufacturing of the TufDuct products.
- Packaging materials

Downstream Processes

The downstream processes include those involved in Module A4 to C4, including:

- Transportation from the production gate to the construction site.
- Transport of waste generated from the construction site.
- Installation of the product on the site.
- Wastage of construction products (additional production processes to compensate for the loss of construction products included in module A1-A3).
- Waste processing of the waste from product wastage during the construction processes up to the end-of-waste state or disposal of final residues.
- Transport of equipment and use of materials for deconstruction at the end of life.
- Transport of waste generated at the end of life.
- Treatment of waste generated at the end of life.

4.6. Cut-off rules

It is common practice in LCA/LCI protocols to propose exclusion limits for inputs and outputs that fall below a threshold % of the total, but with the exception that where the input/output has a “significant” impact it should be included. According to the PCR 2019:14, the Life Cycle Inventory data for a minimum of 95% of total inflows (mass and energy) per module to the upstream and core module shall be included, accounted as global warming potential (GWP) or energy consumption. Inflows not included in the LCA shall be documented in the EPD. Data gap in included stages in the downs stream module shall be reported in the EPD including an evaluation of its significance.

In accordance with the PCR 2019:14, the following system boundaries are applied on manufacturing equipment and employees:

- Environmental impact from infrastructure, construction, production equipment, and tools that are not directly consumed in the production process are not accounted for in the LCI. Capital equipment and buildings typically account for less than a few percent of nearly all LCIs and this is usually smaller than the error in the inventory data itself. For this project, it is assumed that capital equipment makes a negligible contribution to the impacts as per Frischknecht et al[1] with no further investigation.

[1] Frischknecht et. al., International Journal of Life Cycle Assessment, 12, 1-11, 2007

- Personnel-related impacts, such as transportation to and from work, are also not accounted for in the LCI. The impacts of employees are also excluded from inventory impacts on the basis that if they were not employed for this production or service function, they would be employed for another. It is very hard to decide what proportion of the impacts from their whole lives should count towards their employment. For this project, the impacts of employees are excluded.
- Steel bolts accounts 0.3% mass for the production of TufDuct products. The transport of steel bolts for the production of TufDuct products in Japan (A2) was excluded.
- Packaging disposal (land filling) at the end of life was excluded as it is expected to account for <1% of the module's emissions.
- Bolts used for installation were considered to be manufactured overseas. However, the environmental impacts associated to installation bolts are low (<1%) and excluded.

Besides these exclusions, no energy or mass flows were excluded. Furthermore, materials that account less than 1% of total mass input but considered as environmentally relevant such as steel bolts are included in the LCA (see details in Table 5, Table 6,Table 7 and Table 8)

4.7. Allocation

According to the PCR 2019:14, in a process step where more than one type of product is generated, it is necessary to allocate the environmental stressors (inputs and outputs) from the process to the different products (functional outputs) in order to get product-based inventory data instead of process-based data. An allocation problem also occurs for multi-input processes.
In an allocation procedure, the sum of the allocated inputs and outputs to the products shall be equal to the unallocated inputs and outputs of the unit process.
The following stepwise allocation principles shall be applied for multi-input/output allocations:

- The initial allocation step includes dividing up the system sub-processes and collecting the input and output data related to these sub-processes.
- The first (preferably) allocation procedure step for each sub-process is to partition the inputs and outputs of the system into their different products in a way that reflects the underlying physical relationships between them.
- The second (worst case) allocation procedure step is needed when physical relationship alone cannot be established or used as the basis for allocation. In this case, the remaining environmental inputs and outputs from a sub-process must be allocated between the products in a way that reflects other relationships between them, such as the economic value of the products.

There are no co-products from the production of TufDuct's Duct Range production and therefore allocation issues were avoided. All TufDuct product assessed are manufactured in one plant located in Ichihara, Chiba, Japan. Mass and energy data have been sourced from the manufacturing plant by TufDuct. The quantities of materials and electricity required for producing each TufDuct product are calculated on basis of the amount (tonnes) of a particular product manufactured on the site in FY2019-2020 and the associated electricity consumption for that particular product line. This data is also recorded as part of the standard quality assurance purpose.

4.7.1. Recycled content in products

TufDuct's product ranges incorporate recycled content in the polyethyelene used to manufacture them. Based on the guidelines from PCR 2019:14 and EN 15804 A2, the burden of impact from recycled materials has been excluded, but the impacts from processing of the recycled material have been allocated to TufDuct. Essentially, secondary (recycled) materials bear only the impacts of the recycling processes.

4.7.2. Background data

The allocation approach for the LCA databases utilised in this EPD is also compliant with the PCR. More specifically, the burden of primary production of materials is always allocated to the primary user of a material, while secondary (recycled) materials bear only the impacts of the recycling processes.

4.8. Data quality and validation

The primary data used for the study (core module) is based on direct utility bills or feedstock quantities from the TufDuct's procurement records. Primary data was carefully reviewed in order to ensure completeness, accuracy and representativeness of the data supplied. Contribution analysis was used to focus on the key pieces of data contributing to the environmental impact categories. The data was benchmarked against relevant benchmark data in Ecoinvent. Overall, the data was deemed to be of high quality for the core module. According to EN15804 A2, the data quality ranking is as follows: geographical representativeness – very good; technical representativeness – very good and time representativeness – very good.

4.9. LCA modelling scenarios

Three scenarios were assessed to ensure a comprehensive lifecycle analysis of the product:

1. Recycling of ducts at end-of-life (considers A1-A5, C1-C3 and D)[2];
2. Landfill disposal at end-of-life (A1-A5, C1, C2 and C4) and
3. Leaving the ducts as is at end-of-life (A1-A5).

Most of the TufDuct products are still in service and will reach their end-of-life in the next 3-4 decades. The scenarios included in this EPD are based on the most likely outcomes of the products at the end-of-life i.e., they will either be recycled, landfilled or kept as is.

4.10. Compliance with standards

The LCA and EPD have been developed to comply with:

- ISO 14040:2006 and ISO14044:2006+A1:2018 which describe the principles, framework, requirements and provides guidelines for life cycle assessment (LCA) (ISO, 2006; ISO, 2018).
- ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations -- Principles and procedures, which establishes the principles and specifies the procedures for developing Type III environmental declaration programmes and Type III environmental declarations (ISO, 2006).
- EN 15804+A2:2019: Sustainability of construction works – Environmental product declarations - Core rules for the product category of construction products (here after referred to as EN15804+A2).
- Product Category Rules (PCR) 2019:14, v1.1 – Construction products – Hereafter referred to as PCR 2019:14.
- General Programme Instructions (GPI) for the International EPD System V3.01 – containing instructions regarding methodology and the content that must be included in EPDs registered under the International EPD System.
- Instructions of EPD Australasia V3.0 – a regional annex to the general programme instructions of the International EPD System.

[2] Environmental impacts for C4 module are zero as there will be no landfilling for Scenario 1.

4.11. Key assumptions and considerations

- All primary (foreground) data collected for this EPD was sourced from TufDuct via a Request for Information spreadsheet. This data was collected for the financial year 2019/2020 (01 Jul 2019 to 30 Jun 2020).
- Manufacturing waste was assumed to be 1% of the product weight. This was done on the basis of information obtained from Production Manager of Furukawa Industries, Japan which manufactures TufDuct products
- Due to confidentiality, exact flame retardant composition could not be obtained. It was assumed to be 50% Organic + 50% Inorganic. A sensitivity analysis indicated that variation in composition would not affect the environmental impacts in any significant manner (<2%).
- Weighted average distance was calculated for each sector of transport, wherein the weighting factor was based on the quantity of products shipped to a location. This data was provided by TufDuct.

5. Content declaration

Table 2, Table 3 and Table 4 show the material related data for various duct series, while Figure 3 and Figure 4 highlight the proportion of materials used in manufacturing and packaging.

The straight, gradient and elevated series are identical. However, depending on the application, the gradient and elevated series can employ steel posts for increased height. The steel posts are not a part of TufDuct's offering and they have no control over the design or type of material that is used for such purpose. This is highly dependent on the contractor and the end use. Hence the impact for steel posts is not covered in this LCA. We direct the reader to published EPDs by steel manufacturers such as Bluescope, Liberty Steel etc. to understand the environmental impacts of the steel that may be used for gradient and elevated series

Table 2 - Materials used for manufacturing for straight, gradient and elevated duct series.

Series	Product materials (kg per m)					Packaging materials (kg /m)			
	Recycled PE pellet	Filler	Flame retardants	Steel (bolts)	Total	Plastic pallet	Plastic film	Plastic strap	Total
90	4.55	1.05	1.40	0.01	7.01	0.73	0.10	0.01	0.84
135	6.5	1.50	2.00	0.01	10.01	0.73	0.10	0.01	0.84
150	8.45	1.95	2.60	0.01	13.01	0.73	0.10	0.01	0.84
200	13.65	3.15	4.20	0.01	21.01	0.73	0.10	0.01	0.84
300	17.55	4.05	5.40	0.10	27.10	0.73	0.10	0.01	0.84
430	31.2	7.20	9.60	0.10	48.10	0.73	0.10	0.01	0.84

Table 3 - Materials used for manufacturing for bend series.

Series	Product materials (kg per kg of product)					Packaging materials (kg per kg of product)			
	Recycled PE pellet	Filler	Flame retardants	Steel (bolts)	Total	Plastic pallet	Plastic film	Plastic strap	Total
90	0.65	0.15	0.20	0.0046	1.00	0.36	0.05	0.005	0.42
135	0.65	0.15	0.20	0.0023	1.00	0.18	0.03	0.003	0.21
150	0.66	0.15	0.20	0.0018	1.00	0.14	0.02	0.002	0.16
200	0.65	0.15	0.20	0.0012	1.00	0.09	0.01	0.001	0.10
300	0.65	0.15	0.20	0.0081	1.01	0.06	0.01	0.001	0.06
430	0.65	0.15	0.20	0.0055	1.01	0.04	0.01	0.001	0.04

Table 4 - Materials used for manufacturing for tee series.

Series	Product materials (kg per kg of product)					Packaging materials (kg per kg of product)			
	Recycled PE pellet	Filler	Flame retardants	Steel (bolts)	Total	Plastic pallet	Plastic film	Plastic strap	Total
90	0.657	0.152	0.202	0.002	1.01	0.12	0.02	0.002	0.14
135	0.657	0.152	0.202	0.001	1.01	0.09	0.01	0.001	0.10
150	0.655	0.155	0.200	0.001	1.01	0.08	0.01	0.001	0.09
200	0.655	0.154	0.200	0.001	1.01	0.06	0.01	0.001	0.06
300	0.656	0.153	0.201	0.005	1.02	0.03	0.00	0.000	0.04
430	0.657	0.152	0.202	0.003	1.01	0.02	0.00	0.000	0.03

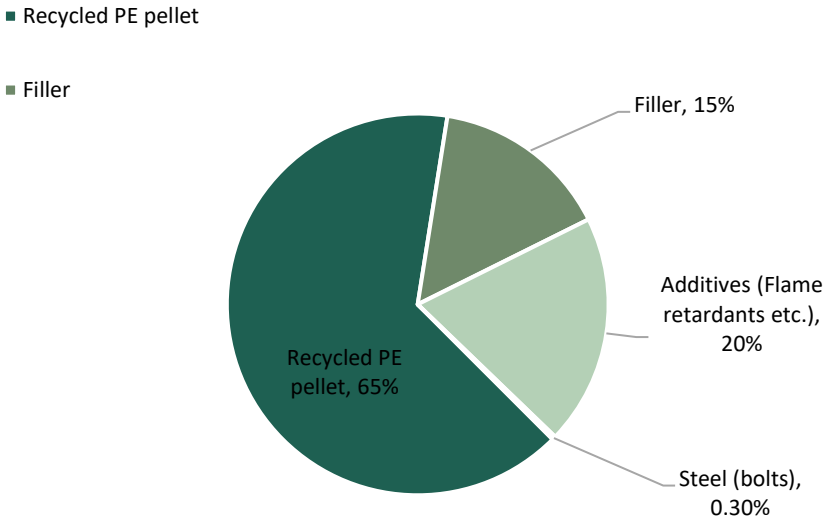


Figure 3: Proportions of materials used in manufacturing of TufDuct duct ranges.

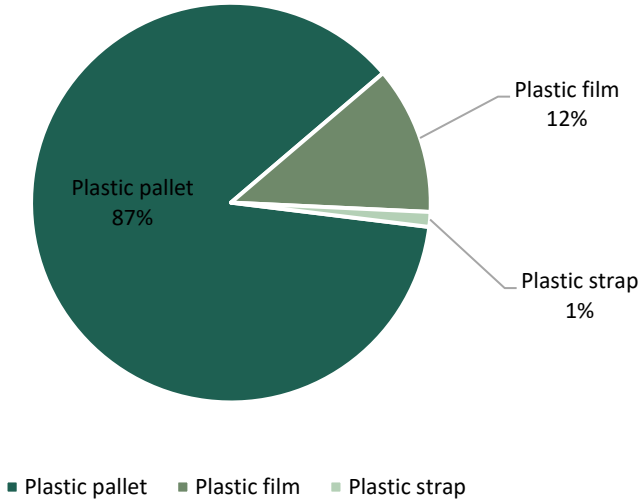


Figure 4: Proportion of materials used for packaging.

None of the products, detailed in Table 2, Table 3 and Table 4, contain one or more substances that are listed in the “Candidate List of Substances of Very High Concern for authorisation”. According to the PCR 2019:14, if one or more substances of the “Candidate List of Substances of Very High Concern (SVHC) for authorisation” are present in a product and their total content exceeds 0.1% of the weight of the product, they need to be reported.

6. Environmental performance

6.1. Environmental performance related information

The potential environmental impacts, use of resources and waste categories included in this EPD were calculated using the SimaPro v9.1.1.1 tool and are listed in Table 5. All tables from this point will contain the abbreviation only. The LCA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds and safety margins or risks. Please refer to Appendix B for guidance on calculating impacts for a certain length of ducting with bend or tee joints.

Table 5 - Life Cycle Impact, Resource and waste Assessment Categories, Measurements and Methods

Impact Category	Abbreviation	Measurement Unit	Assessment Method and Implementation	Disclaimer
Potential Environmental Impacts				
Global warming potential (fossil)	GWPF	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2013	None
Global warming potential (biogenic)	GWPB	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2013	None
Global warming potential (land use/ land transformation)	GWPL	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2013	None
Total global warming potential	GWPT	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2013	None
Acidification potential	AP	mol H+ eq.	Accumulated Exceedance, Seppälä et al. 2006, Posch et al., 2008	None
Eutrophication – aquatic freshwater	EP - freshwater	kg PO_4^{3-} equivalents	CML (v4.1)	None

Impact Category	Abbreviation	Measurement Unit	Assessment Method and Implementation	Disclaimer
Eutrophication – aquatic freshwater	EP - freshwater	kg P equivalent	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe[3]	None
Eutrophication – aquatic marine	EP - marine	kg N equivalent	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe	None
Eutrophication – terrestrial	EP – terrestrial	mol N equlivalent	Accumulated Exceedance, Seppälä et al. 2006, Posch et al.	None
Photochemical ozone creation potential	POCP	kg NMVOC equivalents	LOTOS-EUROS ,Van Zelm et al., 2008, as applied in ReCiPe	None
Abiotic depletion potential (elements)	ADPE	kg Sb equivalents	CML (v4.1)	2
Abiotic depletion potential (fossil fuels)	ADPF	MJ net calorific value	CML (v4.1)	2
Ozone depletion potential	ODP	kg CFC 11 equivalents	Steady-state ODPs, WMO 2014	None
Water Depletion Potential	WDP	m^3 equivalent deprived	Available WAter REmaining (AWARE) Boulay et al., 2016	2
				None
Additional environmental impacts				None

[3] EN 15804:2012+A2:2019 specifies that the unit for the indicator for Eutrophication aquatic freshwater shall be kg PO_4^{3-} eq, although the reference given ("EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe") uses the unit kg P eq. This is likely a typographical error in EN 15804+A2, which is expected to be corrected in a future revision. Until this has been corrected, results for Eutrophication aquatic freshwater shall be given in both kg PO4 eq and kg P eq. in the EPD.

Impact Category	Abbreviation	Measurement Unit	Assessment Method and Implementation	Disclaimer
Global warming potential, excluding biogenic uptake, emissions and storage	GWP-GHG	kg CO_2 equivalents (GWP100)	CML (v4.1)	None
Particulate matter	PM	disease incidence	SETAC-UNEP, Fantke et al. 2016[4]	None
Ionising radiation - human health	IRP	kBq U-235 eq	Human health effect model as developed by Dreicer et al.[5] 1995 update by Frischknecht et al., 2000[6]	1 (Refer to the bottom of the table)
Eco-toxicity (freshwater)	ETP-fw	CTUe	Usetox version 2 until the modified USEtox model is available from EC-JRC	2 (Refer to the bottom of the table)
Human toxicity potential - cancer effects	HTP-c	CTUh	Usetox version 2 until the modified USEtox model is available from EC-JRC	2 (Refer to the bottom of the table)
Human toxicity potential - non cancer effects	HTP-nc	CTUh	Usetox version 2 until the modified Usetox model is available from EC-JRC	2 (Refer to the bottom of the table)
Soil quality	SQP	dimensionless	Soil quality index based on LANCA	2 (Refer to the bottom of the table)
Resource use				None

[4] Fantke et al. , Global Guidance for Life Cycle Impact Assessment Indicators: Volume 1. UNEP/SETAC Life Cycle Initiative, Paris, pp. 76-99
[5] Dreicer et al., 1995. ExternE, Externalities of Energy, Vol. 5. Nuclear, Science, Research and Development JOULE, Luxembourg.
[6] Frischknecht et al., R., 2000. Environmental impact assessment Review, 20, pp.159-189.

Impact Category	Abbreviation	Measurement Unit	Assessment Method and Implementation	Disclaimer
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	PERE	MJ, net calorific value	ecoinvent version 3.6 and expanded by PRé Consultants[7] [8]	None
Use of renewable primary energy resources used as raw materials	PERM	MJ, net calorific value	Manual for direct inputs[9]	None
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	PERT	MJ, net calorific value	ecoinvent version 3.6 and expanded by PRé Consultants	None
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	PENRE	MJ, net calorific value	Manual for direct inputs[10]	None
Use of non- renewable primary energy resources used as raw materials	PENRM	MJ, net calorific value	ecoinvent version 3.6 and expanded by PRé Consultants	None
Total use of non-renewable primary energy resources (primary energy and primary energy	PENRT	MJ, net calorific value	ecoinvent version 3.6 and expanded by PRé Consultants [11]	None

[7] Method to calculate Cumulative Energy Demand (CED), based on the method published by Ecoinvent version 2.0 and expanded by PRé Consultants for raw materials available in the SimaPro database.
[8] Calculated as sum of *Renewable, biomass*, *Renewable, wind, solar, geothermal* and *Renewable, water*.
[9] Calculated based on the lower heating value of renewable raw materials.
[10] Calculated based on the higher heating value of non-renewable raw materials.
[11] Calculated as sum of *Non-renewable, fossil*, *Non-renewable, nuclear* and *Non-renewable, biomass*.

Impact Category	Abbreviation	Measurement Unit	Assessment Method and Implementation	Disclaimer
resources used as raw materials)				
Use of secondary material	SM	kg	Manual for direct inputs	None
Use of renewable secondary fuels	RSF	MJ, net calorific value	Manual for direct inputs	None
Use of non-renewable secondary fuels	NRSF	MJ, net calorific value	Manual for direct inputs	None
Use of net fresh water	FW	m^3	ReCiPe 2016	None
Waste categories				None
Hazardous waste disposed	HWD	kg	EDIP 2003 (v1.05)	None
Non-hazardous waste disposed	NHWD	kg	EDIP 2003 (v1.05) [12]	None
Radioactive waste disposed/stored	RWD	kg	EDIP 2003 (v1.05)	None
Output flows				None
Components for reuse	CRU	kg	Manual for direct inputs	None
Materials for recycling	MFR	kg	Manual for direct inputs	None
Materials for energy recovery	MFRE	kg	Manual for direct inputs	None
Exported energy	EE	MJ per energy carrier	Manual for direct inputs	None
Disclaimer 1 – This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionising radiation from the soil, from radon and from some construction materials is also not measured by this indicator.[13]				
Disclaimer 2 – The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.[13]				

[12] Calculated as sum of *Bulk waste* and *Slags/ash*.
[13] Aligned with PCR 2019:14

6.2. Environmental performance results for Straight, Gradient, and Elevated series – Recycling at EoL scenario

The following results show LCA analysis from straight, gradient and elevated series.[14]

6.2.1. Results for modules A1-A3 (Manufacturing stage)

Table 6 - Environmental impacts per 1 m Straight/Gradient/Elevated Duct for modules A1-A3.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO2 eq.	1.64E+01	2.00E+01	2.48E+01	3.57E+01	4.58E+01	6.94E+01
Global warming potential - Biogenic (GWP - B)	kg CO2 eq.	2.95E-01	4.35E-01	5.72E-01	9.41E-01	1.21E+00	2.20E+00
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO2 eq.	5.01E-03	6.79E-03	8.66E-03	1.35E-02	1.73E-02	2.96E-02
Global warming potential - Total (GWP - T)	**kg CO2 eq.**	**1.67E+01**	**2.04E+01**	**2.54E+01**	**3.67E+01**	**4.70E+01**	**7.16E+01**
Ozone depletion potential (ODP)	kg CFC 11 eq.	9.50E-07	1.26E-06	1.60E-06	2.45E-06	3.15E-06	5.24E-06
Acidification potential (AP)	mol H+ eq.	8.28E-02	1.01E-01	1.25E-01	1.80E-01	2.31E-01	3.49E-01
Eutrophication, freshwater (EP - F)	kg PO43- eq.	2.37E-02	3.09E-02	3.91E-02	5.92E-02	7.59E-02	1.24E-01
Eutrophication, freshwater (EP - F)	kg P eq.	3.44E-03	4.24E-03	5.28E-03	7.67E-03	9.82E-03	1.51E-02
Eutrophication, marine (EP - M)	kg N eq.	1.51E-02	1.88E-02	2.35E-02	3.45E-02	4.43E-02	6.92E-02
Eutrophication, terrestrial (EP - T)	mol N eq.	1.57E-01	1.96E-01	2.45E-01	3.58E-01	4.59E-01	7.17E-01
Photochemical ozone formation (POCP)	kg NMVOC eq.	4.84E-02	6.05E-02	7.57E-02	1.11E-01	1.42E-01	2.23E-01
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	2.99E-04	4.22E-04	5.47E-04	8.77E-04	1.13E-03	1.99E-03
Abiotic depletion potential - Fossil (ADP - F)	MJ	2.17E+02	2.67E+02	3.32E+02	4.81E+02	6.15E+02	9.46E+02
Water depletion Potential (WDP)	m3	3.84E+00	5.07E+00	6.42E+00	9.81E+00	1.25E+01	2.10E+01

[14] The straight, gradient and elevated series are identical. However, depending on the application, the gradient and elevated series can employ steel posts for increased height. The steel posts are not a part of TufDuct's offering and they have no control over the design or type of material that is used for such purpose. This is highly dependent on the contractor and the end use. Hence the impact for steel posts is not covered in this LCA. We direct the reader to published EPDs by steel manufacturers such as Bluescope, Liberty Steel etc. to understand the environmental impacts of the steel that may be used for gradient and elevated series.

Table 7 - Additional environmental impact per 1 m Straight/Gradient/Elevated Duct for modules A1-A3.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	1.58E+01	1.92E+01	2.39E+01	3.43E+01	4.40E+01	6.66E+01
Particulate matter	disease incidence	6.55E-07	8.83E-07	1.13E-06	1.75E-06	2.25E-06	3.82E-06
Ionising radiation - human health	kBq U-235 eq	6.94E-01	8.59E-01	1.07E+00	1.56E+00	1.99E+00	3.09E+00
Eco-toxicity (freshwater)	CTUe	2.31E+02	2.96E+02	3.73E+02	5.59E+02	7.17E+02	1.16E+03
Human toxicity potential - cancer effects	CTUh	1.02E-08	1.38E-08	1.76E-08	2.74E-08	3.51E-08	5.95E-08
Human toxicity potential - non cancer effects	CTUh	1.83E-07	2.41E-07	3.07E-07	4.69E-07	6.02E-07	1.00E-06
Soil quality	dimensionless	6.27E+01	8.21E+01	1.04E+02	1.58E+02	2.03E+02	3.35E+02

Table 8 - Use of resources per 1 m Straight/Gradient/Elevated Duct for modules A1-A3.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
PERE	MJ	1.19E+01	1.44E+01	1.79E+01	2.55E+01	3.27E+01	4.93E+01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	1.19E+01	1.44E+01	1.79E+01	2.55E+01	3.27E+01	4.93E+01
PENRE	MJ	2.34E+02	2.87E+02	3.57E+02	5.16E+02	6.60E+02	1.02E+03
PENRM	MJ.	4.50E+01	6.26E+01	8.02E+01	1.27E+02	1.62E+02	2.85E+02
PENRT	MJ	2.79E+02	3.50E+02	4.37E+02	6.44E+02	8.23E+02	1.30E+03
SM	kg	4.60E+00	6.57E+00	8.53E+00	1.38E+01	1.77E+01	3.15E+01
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	5.31E-02	6.98E-02	8.83E-02	1.35E-01	1.72E-01	2.87E-01

Table 9 - Waste generated per 1 m Straight/Gradient/Elevated Duct for modules A1-A3.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	2.11E-04	2.71E-04	3.43E-04	5.15E-04	6.61E-04	1.07E-03
Non-hazardous waste disposed	kg	2.26E+00	3.13E+00	4.03E+00	6.38E+00	8.20E+00	1.42E+01
Radioactive waste disposed	kg	3.94E-04	5.04E-04	6.35E-04	9.51E-04	1.22E-03	1.96E-03

Table 10 – Output flows generated per 1 m Straight/Gradient/Elevated Duct for modules A1-A3.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.2.2. Results for module A4 (Transport)

Table 11 - Environmental impacts per 1 m Straight/Gradient/Elevated Duct for module A4[15].

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	7.34E-01	1.02E+00	1.30E+00	1.82E+00	2.61E+00	4.58E+00
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	-1.14E-04	-1.57E-04	-2.01E-04	-2.82E-04	-4.04E-04	-7.08E-04
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	4.28E-04	5.91E-04	7.55E-04	1.06E-03	1.52E-03	2.67E-03
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**7.34E-01**	**1.02E+00**	**1.30E+00**	**1.82E+00**	**2.61E+00**	**4.58E+00**
Ozone depletion potential (ODP)	kg CFC 11 eq.	1.47E-07	2.03E-07	2.59E-07	3.64E-07	5.21E-07	9.14E-07
Acidification potential (AP)	mol H^+ eq.	1.94E-02	2.68E-02	3.42E-02	4.81E-02	6.88E-02	1.21E-01
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	1.79E-03	2.47E-03	3.16E-03	4.44E-03	6.35E-03	1.11E-02
Eutrophication, freshwater (EP - F)	kg P eq.	3.19E-05	4.41E-05	5.63E-05	7.92E-05	1.13E-04	1.99E-04
Eutrophication, marine (EP - M)	kg N eq.	4.81E-03	6.65E-03	8.49E-03	1.19E-02	1.71E-02	3.00E-02
Eutrophication, terrestrial (EP - T)	mol N eq.	5.34E-02	7.38E-02	9.42E-02	1.33E-01	1.90E-01	3.33E-01
Photochemical ozone formation (POCP)	kg NMVOC eq.	1.40E-02	1.93E-02	2.47E-02	3.47E-02	4.97E-02	8.71E-02
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	7.18E-06	9.94E-06	1.27E-05	1.78E-05	2.55E-05	4.48E-05
Abiotic depletion potential - Fossil (ADP - F)	MJ	9.65E+00	1.34E+01	1.70E+01	2.40E+01	3.43E+01	6.02E+01
Water depletion Potential (WDP)	m^3	5.72E-01	7.91E-01	1.01E+00	1.42E+00	2.03E+00	3.56E+00

[15] The negative biogenic carbon value is a result of the background process for sea transport using container ships. The main contributor for this is the wood (softwood, glued laminated timer etc.) used for maintenance of the ship. Please refer to the appendix for the network diagram explaining this.

Table 12 - Additional environmental impact per 1 m Straight/Gradient/Elevated Duct for module A4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	7.27E-01	1.01E+00	1.28E+00	1.81E+00	2.58E+00	4.53E+00
Particulate matter	disease incidence	2.78E-08	3.85E-08	4.91E-08	6.91E-08	9.88E-08	1.73E-07
Ionising radiation - human health	kBq U-235 eq	4.07E-02	5.63E-02	7.19E-02	1.01E-01	1.45E-01	2.54E-01
Eco-toxicity (freshwater)	CTUe	6.40E+00	8.85E+00	1.13E+01	1.59E+01	2.27E+01	3.99E+01
Human toxicity potential - cancer effects	CTUh	3.73E-10	5.16E-10	6.58E-10	9.26E-10	1.32E-09	2.32E-09
Human toxicity potential - non cancer effects	CTUh	5.78E-09	7.99E-09	1.02E-08	1.44E-08	2.05E-08	3.60E-08
Soil quality	dimensionless	2.25E+00	3.11E+00	3.98E+00	5.59E+00	8.00E+00	1.40E+01

Table 13 - Use of resources per 1 m Straight/Gradient/Elevated Duct for module A4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
PERE	MJ	8.02E-02	1.11E-01	1.42E-01	1.99E-01	2.85E-01	5.00E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	8.02E-02	1.11E-01	1.42E-01	1.99E-01	2.85E-01	5.00E-01
PENRE	MJ	1.02E+01	1.42E+01	1.81E+01	2.54E+01	3.64E+01	6.39E+01
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.02E+01	1.42E+01	1.81E+01	2.54E+01	3.64E+01	6.39E+01
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	3.26E-04	4.51E-04	5.75E-04	8.09E-04	1.16E-03	2.03E-03

Table 14 - Waste generated per 1 m Straight/Gradient/Elevated Duct for module A4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	1.18E-05	1.64E-05	2.09E-05	2.94E-05	4.20E-05	7.37E-05
Non-hazardous waste disposed	kg	9.64E-02	1.33E-01	1.70E-01	2.39E-01	3.42E-01	6.01E-01
Radioactive waste disposed	kg	6.08E-05	8.41E-05	1.07E-04	1.51E-04	2.16E-04	3.79E-04

Table 15 - Output flows generated per 1 m Straight/Gradient/Elevated Duct for module A4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.2.3. Results for module A5 (Installation)

Table 16 - Environmental impacts per 1 m Straight/Gradient/Elevated Duct for module A5.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO2 eq.	3.13E-01	3.60E-01	4.20E-01	5.50E-01	1.39E+00	1.70E+00
Global warming potential - Biogenic (GWP - B)	kg CO2 eq.	4.91E-03	6.32E-03	7.69E-03	1.14E-02	3.45E-02	4.43E-02
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO2 eq.	1.09E-04	1.29E-04	1.49E-04	2.01E-04	8.11E-04	9.46E-04
Global warming potential - Total (GWP - T)	**kg CO2 eq.**	**3.18E-01**	**3.67E-01**	**4.28E-01**	**5.61E-01**	**1.43E+00**	**1.75E+00**
Ozone depletion potential (ODP)	kg CFC 11 eq.	1.69E-08	2.07E-08	2.48E-08	3.47E-08	8.58E-08	1.12E-07
Acidification potential (AP)	mol H+ eq.	2.11E-03	2.42E-03	2.79E-03	3.57E-03	8.64E-03	1.07E-02
Eutrophication, freshwater (EP - F)	kg PO43- eq.	5.65E-04	6.59E-04	7.63E-04	1.01E-03	2.52E-03	3.16E-03
Eutrophication, freshwater (EP - F)	kg P eq.	6.14E-05	6.98E-05	8.06E-05	1.05E-04	3.98E-04	4.54E-04
Eutrophication, marine (EP - M)	kg N eq.	6.02E-04	6.78E-04	7.65E-04	9.48E-04	1.95E-03	2.47E-03
Eutrophication, terrestrial (EP - T)	mol N eq.	6.05E-03	6.82E-03	7.70E-03	9.56E-03	1.98E-02	2.51E-02
Photochemical ozone formation (POCP)	kg NMVOC eq.	1.67E-03	1.90E-03	2.15E-03	2.69E-03	5.87E-03	7.38E-03
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	5.43E-06	6.70E-06	7.98E-06	1.14E-05	3.79E-05	4.67E-05
Abiotic depletion potential - Fossil (ADP - F)	MJ	3.39E+00	4.01E+00	4.79E+00	6.51E+00	1.62E+01	2.04E+01
Water depletion Potential (WDP)	m3	4.20E-01	5.45E-01	6.71E-01	9.16E-01	1.41E+00	2.29E+00

Table 17 - Additional environmental impact per 1 m Straight/Gradient/Elevated Duct for module A5.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	3.02E-01	3.48E-01	4.05E-01	5.30E-01	1.34E+00	1.64E+00
Particulate matter	disease incidence	1.94E-08	2.20E-08	2.48E-08	3.17E-08	9.44E-08	1.12E-07
Ionising radiation - human health	kBq U-235 eq	1.22E-02	1.40E-02	1.63E-02	2.15E-02	7.59E-02	8.81E-02
Eco-toxicity (freshwater)	CTUe	6.30E+00	7.00E+00	7.82E+00	9.77E+00	4.04E+01	4.51E+01
Human toxicity potential - cancer effects	CTUh	9.89E-10	1.03E-09	1.07E-09	1.17E-09	1.04E-08	1.06E-08
Human toxicity potential - non cancer effects	CTUh	5.34E-09	5.97E-09	6.67E-09	8.38E-09	3.78E-08	4.21E-08
Soil quality	dimensionless	1.12E+00	1.34E+00	1.58E+00	2.17E+00	6.62E+00	8.12E+00

Table 18 - Use of resources per 1 m Straight/Gradient/Elevated Duct for module A5.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
PERE	MJ	2.92E-01	3.21E-01	3.59E-01	4.42E-01	2.23E+00	2.42E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.92E-01	3.21E-01	3.59E-01	4.42E-01	2.23E+00	2.42E+00
PENRE	MJ	3.62E+00	4.28E+00	5.11E+00	6.95E+00	1.73E+01	2.17E+01
PENRM	MJ.	4.50E-01	6.26E-01	8.02E-01	1.27E+00	1.62E+00	2.85E+00
PENRT	MJ	4.07E+00	4.91E+00	5.91E+00	8.22E+00	1.89E+01	2.46E+01
SM	kg	4.60E-02	6.57E-02	8.53E-02	1.38E-01	1.77E-01	3.15E-01
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	9.42E-04	1.20E-03	1.47E-03	2.10E-03	4.64E-03	6.40E-03

Table 19 - Waste generated per 1 m Straight/Gradient/Elevated Duct for module A5.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	3.96E-06	4.63E-06	5.41E-06	7.27E-06	2.44E-05	2.89E-05
Non-hazardous waste disposed	kg	2.73E-01	3.16E-01	3.60E-01	4.47E-01	1.23E+00	1.53E+00
Radioactive waste disposed	kg	6.68E-06	8.02E-06	9.58E-06	1.32E-05	3.74E-05	4.66E-05

Table 20 - Output flows generated per 1 m Straight/Gradient/Elevated Duct for module A5.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.2.4. Results for module C1 (Deconstruction and demolition)

Table 21 - Environmental impacts per 1 m Straight/Gradient/Elevated Duct for module C1.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	5.24E-03	5.24E-03	5.24E-03	5.24E-03	5.24E-03	5.24E-03
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	4.55E-07	4.55E-07	4.55E-07	4.55E-07	4.55E-07	4.55E-07
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	2.37E-10	2.37E-10	2.37E-10	2.37E-10	2.37E-10	2.37E-10
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**5.24E-03**	**5.24E-03**	**5.24E-03**	**5.24E-03**	**5.24E-03**	**5.24E-03**
Ozone depletion potential (ODP)	kg CFC 11 eq.	9.21E-13	9.21E-13	9.21E-13	9.21E-13	9.21E-13	9.21E-13
Acidification potential (AP)	mol H^+ eq.	1.54E-04	1.54E-04	1.54E-04	1.54E-04	1.54E-04	1.54E-04
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	2.62E-05	2.62E-05	2.62E-05	2.62E-05	2.62E-05	2.62E-05
Eutrophication, freshwater (EP - F)	kg P eq.	7.17E-09	7.17E-09	7.17E-09	7.17E-09	7.17E-09	7.17E-09
Eutrophication, marine (EP - M)	kg N eq.	7.81E-05	7.81E-05	7.81E-05	7.81E-05	7.81E-05	7.81E-05
Eutrophication, terrestrial (EP - T)	mol N eq.	8.56E-04	8.56E-04	8.56E-04	8.56E-04	8.56E-04	8.56E-04
Photochemical ozone formation (POCP)	kg NMVOC eq.	2.27E-04	2.27E-04	2.27E-04	2.27E-04	2.27E-04	2.27E-04
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	2.33E-10	2.33E-10	2.33E-10	2.33E-10	2.33E-10	2.33E-10
Abiotic depletion potential - Fossil (ADP - F)	MJ	2.19E-03	2.19E-03	2.19E-03	2.19E-03	2.19E-03	2.19E-03
Water depletion Potential (WDP)	m^3	5.16E-03	5.16E-03	5.16E-03	5.16E-03	5.16E-03	5.16E-03

Table 22 - Additional environmental impact per 1 m Straight/Gradient/Elevated Duct for module C1.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	5.07E-03	5.07E-03	5.07E-03	5.07E-03	5.07E-03	5.07E-03
Particulate matter	disease incidence	5.17E-09	5.17E-09	5.17E-09	5.17E-09	5.17E-09	5.17E-09
Ionising radiation - human health	kBq U-235 eq	6.42E-08	6.42E-08	6.42E-08	6.42E-08	6.42E-08	6.42E-08
Eco-toxicity (freshwater)	CTUe	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01	1.20E-01
Human toxicity potential - cancer effects	CTUh	1.04E-12	1.04E-12	1.04E-12	1.04E-12	1.04E-12	1.04E-12
Human toxicity potential - non cancer effects	CTUh	1.23E-10	1.23E-10	1.23E-10	1.23E-10	1.23E-10	1.23E-10
Soil quality	dimensionless	5.20E-04	5.20E-04	5.20E-04	5.20E-04	5.20E-04	5.20E-04

Table 23 - Use of resources per 1 m Straight/Gradient/Elevated Duct for module C1.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
PERE	MJ	1.61E-04	1.61E-04	1.61E-04	1.61E-04	1.61E-04	1.61E-04
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	1.61E-04	1.61E-04	1.61E-04	1.61E-04	1.61E-04	1.61E-04
PENRE	MJ	2.20E-03	2.20E-03	2.20E-03	2.20E-03	2.20E-03	2.20E-03
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.20E-03	2.20E-03	2.20E-03	2.20E-03	2.20E-03	2.20E-03
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	3.49E-07	3.49E-07	3.49E-07	3.49E-07	3.49E-07	3.49E-07

Table 24 - Waste generated per 1 m Straight/Gradient/Elevated Duct for module C1.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	7.68E-10	7.68E-10	7.68E-10	7.68E-10	7.68E-10	7.68E-10
Non-hazardous waste disposed	kg	1.19E-05	1.19E-05	1.19E-05	1.19E-05	1.19E-05	1.19E-05
Radioactive waste disposed	kg	1.37E-11	1.37E-11	1.37E-11	1.37E-11	1.37E-11	1.37E-11

Table 25 - Output flows generated per 1 m Straight/Gradient/Elevated Duct for module C1.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.2.5. Results for module C2 (EoL transport)

Table 26 - Environmental impacts per 1 m Straight/Gradient/Elevated Duct for module C2.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	6.35E-02	9.07E-02	1.18E-01	1.69E-01	2.46E-01	4.36E-01
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	7.47E-06	1.07E-05	1.39E-05	1.99E-05	2.89E-05	5.13E-05
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	3.01E-06	4.30E-06	5.59E-06	8.01E-06	1.16E-05	2.07E-05
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**6.36E-02**	**9.07E-02**	**1.18E-01**	**1.69E-01**	**2.46E-01**	**4.36E-01**
Ozone depletion potential (ODP)	kg CFC 11 eq.	1.01E-08	1.44E-08	1.88E-08	2.69E-08	3.91E-08	6.94E-08
Acidification potential (AP)	mol H^+ eq.	4.73E-04	6.76E-04	8.78E-04	1.26E-03	1.83E-03	3.25E-03
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	5.85E-05	8.36E-05	1.09E-04	1.56E-04	2.26E-04	4.02E-04
Eutrophication, freshwater (EP - F)	kg P eq.	2.46E-06	3.51E-06	4.56E-06	6.53E-06	9.51E-06	1.69E-05
Eutrophication, marine (EP - M)	kg N eq.	1.35E-04	1.93E-04	2.50E-04	3.59E-04	5.22E-04	9.26E-04
Eutrophication, terrestrial (EP - T)	mol N eq.	1.48E-03	2.11E-03	2.74E-03	3.93E-03	5.72E-03	1.01E-02
Photochemical ozone formation (POCP)	kg NMVOC eq.	4.69E-04	6.69E-04	8.70E-04	1.25E-03	1.81E-03	3.22E-03
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	3.99E-07	5.70E-07	7.40E-07	1.06E-06	1.54E-06	2.74E-06
Abiotic depletion potential - Fossil (ADP - F)	MJ	8.61E-01	1.23E+00	1.60E+00	2.29E+00	3.33E+00	5.91E+00
Water depletion Potential (WDP)	m^3	4.73E-01	6.75E-01	8.77E-01	1.26E+00	1.83E+00	3.24E+00

Table 27 - Additional environmental impact per 1 m Straight/Gradient/Elevated Duct for module C2.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	6.23E-02	8.90E-02	1.16E-01	1.66E-01	2.41E-01	4.28E-01
Particulate matter	disease incidence	3.33E-09	4.75E-09	6.17E-09	8.84E-09	1.29E-08	2.28E-08
Ionising radiation - human health	kBq U-235 eq	5.97E-04	8.53E-04	1.11E-03	1.59E-03	2.31E-03	4.10E-03
Eco-toxicity (freshwater)	CTUe	5.24E-01	7.49E-01	9.73E-01	1.39E+00	2.03E+00	3.60E+00
Human toxicity potential - cancer effects	CTUh	1.72E-11	2.46E-11	3.20E-11	4.58E-11	6.66E-11	1.18E-10
Human toxicity potential - non cancer effects	CTUh	6.97E-10	9.96E-10	1.29E-09	1.85E-09	2.70E-09	4.79E-09
Soil quality	dimensionless	2.67E-01	3.81E-01	4.96E-01	7.10E-01	1.03E+00	1.83E+00

Table 28 - Use of resources per 1 m Straight/Gradient/Elevated Duct for module C2.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
PERE	MJ	9.96E-03	1.42E-02	1.85E-02	2.65E-02	3.85E-02	6.83E-02
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	9.96E-03	1.42E-02	1.85E-02	2.65E-02	3.85E-02	6.83E-02
PENRE	MJ	9.10E-01	1.30E+00	1.69E+00	2.42E+00	3.52E+00	6.24E+00
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	9.10E-01	1.30E+00	1.69E+00	2.42E+00	3.52E+00	6.24E+00
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	9.84E-05	1.41E-04	1.83E-04	2.62E-04	3.80E-04	6.75E-04

Table 29 - Waste generated per 1 m Straight/Gradient/Elevated Duct for module C2.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	1.33E-06	1.90E-06	2.46E-06	3.53E-06	5.14E-06	9.11E-06
Non-hazardous waste disposed	kg	1.08E-02	1.54E-02	2.00E-02	2.86E-02	4.16E-02	7.38E-02
Radioactive waste disposed	kg	7.55E-07	1.08E-06	1.40E-06	2.01E-06	2.92E-06	5.18E-06

Table 30 - Output flows generated per 1 m Straight/Gradient/Elevated Duct for module C2.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.2.6. Results for module C3 (Waste processing)

Table 31 - Environmental impacts per 1 m Straight/Gradient/Elevated Duct for module C3.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	3.51E+00	5.01E+00	6.51E+00	9.32E+00	1.36E+01	2.41E+01
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	3.44E-03	4.90E-03	6.36E-03	9.10E-03	1.35E-02	2.37E-02
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	5.80E-05	8.29E-05	1.08E-04	1.54E-04	2.24E-04	3.98E-04
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**3.51E+00**	**5.01E+00**	**6.51E+00**	**9.32E+00**	**1.37E+01**	**2.42E+01**
Ozone depletion potential (ODP)	kg CFC 11 eq.	2.81E-08	4.01E-08	5.22E-08	7.47E-08	1.09E-07	1.93E-07
Acidification potential (AP)	mol H^+ eq.	2.18E-02	3.11E-02	4.04E-02	5.78E-02	8.47E-02	1.50E-01
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	2.74E-03	3.91E-03	5.08E-03	7.28E-03	1.06E-02	1.88E-02
Eutrophication, freshwater (EP - F)	kg P eq.	8.73E-05	1.25E-04	1.62E-04	2.32E-04	3.38E-04	5.99E-04
Eutrophication, marine (EP - M)	kg N eq.	7.18E-03	1.02E-02	1.33E-02	1.91E-02	2.78E-02	4.93E-02
Eutrophication, terrestrial (EP - T)	mol N eq.	7.83E-02	1.12E-01	1.45E-01	2.08E-01	3.03E-01	5.38E-01
Photochemical ozone formation (POCP)	kg NMVOC eq.	1.93E-02	2.75E-02	3.58E-02	5.12E-02	7.47E-02	1.32E-01
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	3.40E-06	4.86E-06	6.32E-06	9.05E-06	1.32E-05	2.34E-05
Abiotic depletion potential - Fossil (ADP - F)	MJ	3.75E+01	5.35E+01	6.95E+01	9.96E+01	1.45E+02	2.57E+02
Water depletion Potential (WDP)	m^3	4.92E+01	7.01E+01	9.11E+01	1.30E+02	1.92E+02	3.39E+02

Table 32 - Additional environmental impact per 1 m Straight/Gradient/Elevated Duct for module C3.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	3.39E+00	4.84E+00	6.29E+00	9.00E+00	1.32E+01	2.33E+01
Particulate matter	disease incidence	8.82E-08	1.26E-07	1.63E-07	2.34E-07	3.45E-07	6.08E-07
Ionising radiation - human health	kBq U-235 eq	5.38E-03	7.68E-03	9.99E-03	1.43E-02	2.08E-02	3.69E-02
Eco-toxicity (freshwater)	CTUe	8.13E+00	1.16E+01	1.51E+01	2.16E+01	3.17E+01	5.59E+01
Human toxicity potential - cancer effects	CTUh	4.32E-10	6.16E-10	8.00E-10	1.14E-09	1.68E-09	2.97E-09
Human toxicity potential - non cancer effects	CTUh	7.84E-09	1.12E-08	1.45E-08	2.08E-08	3.05E-08	5.39E-08
Soil quality	dimensionless	4.07E+00	5.81E+00	7.54E+00	1.08E+01	1.59E+01	2.81E+01

Table 33 - Use of resources per 1 m Straight/Gradient/Elevated Duct for module C3.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
PERE	MJ	1.47E+00	2.09E+00	2.72E+00	3.89E+00	5.77E+00	1.01E+01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	1.47E+00	2.09E+00	2.72E+00	3.89E+00	5.77E+00	1.01E+01
PENRE	MJ	3.76E+01	5.37E+01	6.98E+01	1.00E+02	1.46E+02	2.58E+02
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	3.76E+01	5.37E+01	6.98E+01	1.00E+02	1.46E+02	2.58E+02
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	3.98E-02	5.68E-02	7.39E-02	1.06E-01	1.54E-01	2.73E-01

Table 34 - Waste generated per 1 m Straight/Gradient/Elevated Duct for module C3.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	5.04E-06	7.19E-06	9.34E-06	1.34E-05	1.96E-05	3.47E-05
Non-hazardous waste disposed	kg	2.11E+00	3.02E+00	3.93E+00	5.62E+00	8.17E+00	1.45E+01
Radioactive waste disposed	kg	1.69E-06	2.41E-06	3.14E-06	4.49E-06	6.52E-06	1.16E-05

Table 35 - Output flows generated per 1 m Straight/Gradient/Elevated Duct for module C3.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	7.00E+00	1.00E+01	1.30E+01	1.86E+01	2.70E+01	4.80E+01
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.2.7. Results for module C4[16]

Table 36 - Environmental impacts per 1 m Straight/Gradient/Elevated Duct for module C4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ozone depletion potential (ODP)	kg CFC 11 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acidification potential (AP)	mol H^+ eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eutrophication, freshwater (EP - F)	kg P eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eutrophication, marine (EP - M)	kg N eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eutrophication, terrestrial (EP - T)	mol N eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Photochemical ozone formation (POCP)	kg NMVOC eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Abiotic depletion potential - Fossil (ADP - F)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Water depletion Potential (WDP)	m^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

[16] Environmental impacts for C4 module are zero as there will be no landfilling for Scenario 1.

Table 37 - Additional environmental impact per 1 m Straight/Gradient/Elevated Duct for module C4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Particulate matter	disease incidence	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ionising radiation - human health	kBq U-235 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eco-toxicity (freshwater)	CTUe	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Human toxicity potential - cancer effects	CTUh	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Human toxicity potential - non cancer effects	CTUh	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Soil quality	dimensionless	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 38 - Use of resources per 1 m Straight/Gradient/Elevated Duct for module C4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
PERE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 39 - Waste generated per 1 m Straight/Gradient/Elevated Duct for module C4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-hazardous waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 40 - Output flows generated per 1 m Straight/Gradient/Elevated Duct for module C4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.2.8. Results for module D (Recycling benefits beyond the system boundary)

Table 41 - Environmental impacts per 1 m Straight/Gradient/Elevated Duct for module D.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	-1.12E+01	-1.61E+01	-2.09E+01	-2.99E+01	-4.35E+01	-7.72E+01
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	-5.84E-02	-8.35E-02	-1.09E-01	-1.55E-01	-2.25E-01	-4.00E-01
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	-3.44E-03	-4.91E-03	-6.39E-03	-9.15E-03	-1.33E-02	-2.36E-02
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	-1.13E+01	-1.61E+01	-2.10E+01	-3.00E+01	-4.38E+01	-7.76E+01
Ozone depletion potential (ODP)	kg CFC 11 eq.	-2.87E-07	-4.09E-07	-5.32E-07	-7.62E-07	-1.11E-06	-1.97E-06
Acidification potential (AP)	mol H^+ eq.	-4.04E-02	-5.77E-02	-7.50E-02	-1.07E-01	-1.57E-01	-2.78E-01
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	-8.37E-03	-1.19E-02	-1.55E-02	-2.22E-02	-3.27E-02	-5.76E-02
Eutrophication, freshwater (EP - F)	kg P eq.	-1.83E-03	-2.60E-03	-3.38E-03	-4.83E-03	-7.16E-03	-1.26E-02
Eutrophication, marine (EP - M)	kg N eq.	-7.26E-03	-1.04E-02	-1.35E-02	-1.93E-02	-2.82E-02	-4.99E-02
Eutrophication, terrestrial (EP - T)	mol N eq.	-7.72E-02	-1.10E-01	-1.43E-01	-2.05E-01	-2.99E-01	-5.30E-01
Photochemical ozone formation (POCP)	kg NMVOC eq.	-3.76E-02	-5.36E-02	-6.97E-02	-9.98E-02	-1.46E-01	-2.58E-01
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	-1.01E-04	-1.44E-04	-1.87E-04	-2.68E-04	-3.92E-04	-6.93E-04
Abiotic depletion potential - Fossil (ADP - F)	MJ	-3.97E+02	-5.67E+02	-7.37E+02	-1.06E+03	-1.53E+03	-2.72E+03
Water depletion Potential (WDP)	m^3	-9.01E+00	-1.29E+01	-1.67E+01	-2.40E+01	-3.48E+01	-6.18E+01

Table 42 - Additional environmental impact per 1 m Straight/Gradient/Elevated Duct for module D.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	-1.05E+01	-1.49E+01	-1.94E+01	-2.78E+01	-4.05E+01	-7.19E+01
Particulate matter	disease incidence	-3.38E-07	-4.82E-07	-6.26E-07	-8.96E-07	-1.32E-06	-2.33E-06
Ionising radiation - human health	kBq U-235 eq	-7.52E-01	-1.07E+00	-1.40E+00	-2.00E+00	-2.91E+00	-5.16E+00
Eco-toxicity (freshwater)	CTUe	-6.38E+01	-9.07E+01	-1.18E+02	-1.68E+02	-2.55E+02	-4.43E+02
Human toxicity potential - cancer effects	CTUh	-3.13E-09	-4.40E-09	-5.67E-09	-8.04E-09	-1.34E-08	-2.23E-08
Human toxicity potential - non cancer effects	CTUh	-7.27E-08	-1.04E-07	-1.34E-07	-1.92E-07	-2.86E-07	-5.02E-07
Soil quality	dimensionless	-1.30E+01	-1.86E+01	-2.41E+01	-3.45E+01	-5.08E+01	-8.96E+01

Table 43 - Use of resources per 1 m Straight/Gradient/Elevated Duct for module D.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
PERE	MJ	-6.67E+00	-9.52E+00	-1.24E+01	-1.77E+01	-2.59E+01	-4.59E+01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	-6.67E+00	-9.52E+00	-1.24E+01	-1.77E+01	-2.59E+01	-4.59E+01
PENRE	MJ	-4.26E+02	-6.08E+02	-7.90E+02	-1.13E+03	-1.64E+03	-2.92E+03
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	-4.26E+02	-6.08E+02	-7.90E+02	-1.13E+03	-1.64E+03	-2.92E+03
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	-7.04E-02	-1.01E-01	-1.31E-01	-1.87E-01	-2.72E-01	-4.83E-01

Table 44 - Waste generated per 1 m Straight/Gradient/Elevated Duct for module D.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	-4.95E-05	-7.01E-05	-9.07E-05	-1.29E-04	-2.02E-04	-3.46E-04
Non-hazardous waste disposed	kg	-3.73E-01	-5.28E-01	-6.84E-01	-9.76E-01	-1.51E+00	-2.60E+00
Radioactive waste disposed	kg	-2.36E-04	-3.37E-04	-4.38E-04	-6.28E-04	-9.13E-04	-1.62E-03

Table 45 - Output flows generated per 1 m Straight/Gradient/Elevated Duct for module D.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.3. Environmental performance results for Straight, Gradient, and Elevated series – Landfilling at EoL scenario.

All results except those for modules C3, C4 and D are same for the landfilling and recycling at EoL scenario. For the landfilling scenario module C3 and D will have zero impact, whereas the results for module C4 are provided below:

6.3.1. Results for modules C4 (Disposal)

Table 46 - Environmental impacts per 1 m Straight/Gradient/Elevated Duct for module C4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	2.28E-01	3.25E-01	4.23E-01	6.06E-01	8.79E-01	1.56E+00
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	8.66E-05	1.24E-04	1.61E-04	2.30E-04	3.34E-04	5.94E-04
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	6.21E-06	8.87E-06	1.15E-05	1.65E-05	2.40E-05	4.26E-05
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**2.28E-01**	**3.25E-01**	**4.23E-01**	**6.06E-01**	**8.79E-01**	**1.56E+00**
Ozone depletion potential (ODP)	kg CFC 11 eq.	1.55E-08	2.21E-08	2.88E-08	4.12E-08	6.00E-08	1.06E-07
Acidification potential (AP)	mol H^+ eq.	1.07E-03	1.53E-03	1.98E-03	2.84E-03	4.12E-03	7.32E-03
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	4.31E-03	6.15E-03	8.00E-03	1.15E-02	1.66E-02	2.95E-02
Eutrophication, freshwater (EP - F)	kg P eq.	5.84E-06	8.35E-06	1.09E-05	1.55E-05	2.26E-05	4.01E-05
Eutrophication, marine (EP - M)	kg N eq.	2.16E-03	3.09E-03	4.01E-03	5.75E-03	8.34E-03	1.48E-02
Eutrophication, terrestrial (EP - T)	mol N eq.	3.47E-03	4.95E-03	6.44E-03	9.23E-03	1.34E-02	2.38E-02
Photochemical ozone formation (POCP)	kg NMVOC eq.	1.04E-03	1.49E-03	1.94E-03	2.78E-03	4.03E-03	7.16E-03
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	6.03E-07	8.61E-07	1.12E-06	1.60E-06	2.33E-06	4.13E-06
Abiotic depletion potential - Fossil (ADP - F)	MJ	1.47E+00	2.10E+00	2.73E+00	3.91E+00	5.69E+00	1.01E+01
Water depletion Potential (WDP)	m^3	1.30E+00	1.86E+00	2.41E+00	3.46E+00	5.02E+00	8.91E+00

Table 47 - Additional environmental impact per 1 m Straight/Gradient/Elevated Duct for module C4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	2.00E-01	2.86E-01	3.71E-01	5.32E-01	7.72E-01	1.37E+00
Particulate matter	disease incidence	7.71E-09	1.10E-08	1.43E-08	2.05E-08	2.97E-08	5.29E-08
Ionising radiation - human health	kBq U-235 eq	1.15E-03	1.65E-03	2.14E-03	3.07E-03	4.46E-03	7.91E-03
Eco-toxicity (freshwater)	CTUe	1.72E+00	2.46E+00	3.19E+00	4.58E+00	6.64E+00	1.18E+01
Human toxicity potential - cancer effects	CTUh	4.37E-11	6.24E-11	8.11E-11	1.16E-10	1.69E-10	3.00E-10
Human toxicity potential - non cancer effects	CTUh	1.66E-09	2.37E-09	3.08E-09	4.41E-09	6.39E-09	1.14E-08
Soil quality	dimensionless	1.08E+00	1.54E+00	2.00E+00	2.86E+00	4.18E+00	7.40E+00

Table 48 - Use of resources per 1 m Straight/Gradient/Elevated Duct for module C4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
PERE	MJ	2.44E-02	3.49E-02	4.53E-02	6.49E-02	9.42E-02	1.67E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.44E-02	3.49E-02	4.53E-02	6.49E-02	9.42E-02	1.67E-01
PENRE	MJ	1.55E+00	2.21E+00	2.88E+00	4.12E+00	5.99E+00	1.06E+01
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.55E+00	2.21E+00	2.88E+00	4.12E+00	5.99E+00	1.06E+01
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	3.54E-04	5.05E-04	6.56E-04	9.39E-04	1.37E-03	2.43E-03

Table 49 - Waste generated per 1 m Straight/Gradient/Elevated Duct for module C4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	2.22E-06	3.17E-06	4.13E-06	5.91E-06	8.58E-06	1.52E-05
Non-hazardous waste disposed	kg	6.72E+00	9.59E+00	1.25E+01	1.79E+01	2.60E+01	4.61E+01
Radioactive waste disposed	kg	1.33E-06	1.90E-06	2.47E-06	3.53E-06	5.13E-06	9.11E-06

Table 50 - Output flows generated per 1 m Straight/Gradient/Elevated Duct for module C4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.4. Environmental performance results for Straight, Gradient, and Elevated series – Leaving the ducts ‘as is’ at EoL

All results except those for modules C1-C4, and D are same for this scenario and recycling at EoL. Impacts for C1-C4 and D will be zero in this case.

6.5. Environmental performance results for Bend series – Recycling at EoL scenario

6.5.1. Results for modules A1-A3 (Manufacturing stage)

Table 51 - Environmental impacts per 1 kg Bend Connector for modules A1-A3.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	4.79E+00	2.94E+00	2.77E+00	2.36E+00	1.91E+00	1.82E+00
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	3.23E-02	3.96E-02	4.04E-02	4.23E-02	4.39E-02	4.44E-02
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	9.92E-04	7.88E-04	7.59E-04	7.12E-04	6.65E-04	6.52E-04
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**4.82E+00**	**2.98E+00**	**2.81E+00**	**2.40E+00**	**1.95E+00**	**1.86E+00**
Ozone depletion potential (ODP)	kg CFC 11 eq.	2.08E-07	1.54E-07	1.48E-07	1.36E-07	1.23E-07	1.20E-07
Acidification potential (AP)	mol H^+ eq.	2.42E-02	1.49E-02	1.40E-02	1.19E-02	9.61E-03	9.16E-03
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	5.58E-03	3.93E-03	3.76E-03	3.40E-03	3.00E-03	2.92E-03
Eutrophication, freshwater (EP - F)	kg P eq.	9.71E-04	6.09E-04	5.73E-04	4.93E-04	4.05E-04	3.87E-04
Eutrophication, marine (EP - M)	kg N eq.	4.08E-03	2.62E-03	2.48E-03	2.16E-03	1.80E-03	1.73E-03
Eutrophication, terrestrial (EP - T)	mol N eq.	4.28E-02	2.74E-02	2.59E-02	2.25E-02	1.87E-02	1.80E-02
Photochemical ozone formation (POCP)	kg NMVOC eq.	1.31E-02	8.44E-03	7.97E-03	6.94E-03	5.81E-03	5.57E-03
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	4.63E-05	4.37E-05	4.29E-05	4.27E-05	4.19E-05	4.18E-05
Abiotic depletion potential - Fossil (ADP - F)	MJ	6.22E+01	3.88E+01	3.63E+01	3.11E+01	2.55E+01	2.43E+01
Water depletion Potential (WDP)	m^3	8.60E-01	6.29E-01	5.96E-01	5.47E-01	4.91E-01	4.78E-01

Table 52 - Additional environmental impact per 1 kg Bend Connector for modules A1-A3.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	4.62E+00	2.83E+00	2.67E+00	2.27E+00	1.83E+00	1.75E+00
Particulate matter	disease incidence	1.32E-07	1.03E-07	9.98E-08	9.37E-08	8.66E-08	8.51E-08
Ionising radiation - human health	kBq U-235 eq	1.95E-01	1.23E-01	1.16E-01	9.95E-02	8.21E-02	7.84E-02
Eco-toxicity (freshwater)	CTUe	5.71E+01	3.89E+01	3.71E+01	3.31E+01	2.87E+01	2.78E+01
Human toxicity potential - cancer effects	CTUh	2.07E-09	1.61E-09	1.56E-09	1.46E-09	1.35E-09	1.33E-09
Human toxicity potential - non cancer effects	CTUh	4.08E-08	2.98E-08	2.88E-08	2.62E-08	2.36E-08	2.30E-08
Soil quality	dimensionless	1.44E+01	1.03E+01	9.88E+00	8.98E+00	7.99E+00	7.78E+00

Table 53 - Use of resources per 1 kg Bend Connector for modules A1-A3.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
PERE	MJ	3.53E+00	2.15E+00	2.02E+00	1.71E+00	1.37E+00	1.30E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	3.53E+00	2.15E+00	2.02E+00	1.71E+00	1.37E+00	1.30E+00
PENRE	MJ	6.69E+01	4.17E+01	3.91E+01	3.35E+01	2.74E+01	2.61E+01
PENRM	MJ.	7.88E+00	6.87E+00	6.54E+00	6.36E+00	6.12E+00	6.04E+00
PENRT	MJ	7.48E+01	4.86E+01	4.56E+01	3.98E+01	3.35E+01	3.21E+01
SM	kg	6.57E-01	6.57E-01	6.54E-01	6.57E-01	6.55E-01	6.56E-01
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	1.21E-02	8.73E-03	8.28E-03	7.57E-03	6.76E-03	6.58E-03

Table 54 - Waste generated per 1 kg Bend Connector for modules A1-A3.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	5.14E-05	3.53E-05	3.38E-05	3.03E-05	2.63E-05	2.55E-05
Non-hazardous waste disposed	kg	3.97E-01	3.42E-01	3.35E-01	3.23E-01	3.10E-01	3.07E-01
Radioactive waste disposed	kg	9.83E-05	6.66E-05	6.35E-05	5.64E-05	4.88E-05	4.72E-05

Table 55 - Output flows generated per 1 kg Bend Connector for modules A1-A3.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.5.2. Results for module A4 (Transport)

Table 56 - Environmental impacts per 1 kg Bend Connector for module A4[17].

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	1.33E-01	1.13E-01	1.09E-01	1.03E-01	9.97E-02	9.78E-02
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	-2.06E-05	-1.75E-05	-1.69E-05	-1.60E-05	-1.54E-05	-1.51E-05
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	7.74E-05	6.60E-05	6.35E-05	6.03E-05	5.81E-05	5.70E-05
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**1.33E-01**	**1.13E-01**	**1.09E-01**	**1.04E-01**	**9.97E-02**	**9.78E-02**
Ozone depletion potential (ODP)	kg CFC 11 eq.	2.65E-08	2.26E-08	2.18E-08	2.07E-08	1.99E-08	1.95E-08
Acidification potential (AP)	mol H^+ eq.	3.51E-03	2.99E-03	2.88E-03	2.73E-03	2.63E-03	2.58E-03
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	3.23E-04	2.76E-04	2.65E-04	2.52E-04	2.43E-04	2.38E-04
Eutrophication, freshwater (EP - F)	kg P eq.	5.77E-06	4.92E-06	4.74E-06	4.50E-06	4.33E-06	4.25E-06
Eutrophication, marine (EP - M)	kg N eq.	8.70E-04	7.41E-04	7.14E-04	6.77E-04	6.53E-04	6.40E-04
Eutrophication, terrestrial (EP - T)	mol N eq.	9.65E-03	8.23E-03	7.92E-03	7.52E-03	7.24E-03	7.11E-03
Photochemical ozone formation (POCP)	kg NMVOC eq.	2.53E-03	2.16E-03	2.08E-03	1.97E-03	1.90E-03	1.86E-03
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	1.30E-06	1.11E-06	1.07E-06	1.01E-06	9.75E-07	9.57E-07
Abiotic depletion potential - Fossil (ADP - F)	MJ	1.75E+00	1.49E+00	1.43E+00	1.36E+00	1.31E+00	1.29E+00
Water depletion Potential (WDP)	m^3	1.03E-01	8.82E-02	8.49E-02	8.06E-02	7.76E-02	7.62E-02

[17] The negative biogenic carbon value is a result of the background process for sea transport using container ships. The main contributor for this is the wood (softwood, glued laminated timer etc.) used for maintenance of the ship. Please refer to the appendix for the network diagram explaining this.

Table 57 - Additional environmental impact per 1 kg Bend Connector for module A4.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	1.32E-01	1.12E-01	1.08E-01	1.03E-01	9.87E-02	9.69E-02
Particulate matter	disease incidence	5.03E-09	4.29E-09	4.13E-09	3.92E-09	3.78E-09	3.71E-09
Ionising radiation - human health	kBq U-235 eq	7.37E-03	6.28E-03	6.05E-03	5.74E-03	5.53E-03	5.42E-03
Eco-toxicity (freshwater)	CTUe	1.16E+00	9.87E-01	9.50E-01	9.02E-01	8.69E-01	8.52E-01
Human toxicity potential - cancer effects	CTUh	6.75E-11	5.75E-11	5.54E-11	5.26E-11	5.06E-11	4.97E-11
Human toxicity potential - non cancer effects	CTUh	1.05E-09	8.92E-10	8.58E-10	8.15E-10	7.85E-10	7.70E-10
Soil quality	dimensionless	4.07E-01	3.47E-01	3.35E-01	3.17E-01	3.06E-01	3.00E-01

Table 58 - Use of resources per 1 kg Bend Connector for module A4.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
PERE	MJ	1.45E-02	1.24E-02	1.19E-02	1.13E-02	1.09E-02	1.07E-02
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	1.45E-02	1.24E-02	1.19E-02	1.13E-02	1.09E-02	1.07E-02
PENRE	MJ	1.85E+00	1.58E+00	1.52E+00	1.44E+00	1.39E+00	1.36E+00
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.85E+00	1.58E+00	1.52E+00	1.44E+00	1.39E+00	1.36E+00
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	5.89E-05	5.03E-05	4.84E-05	4.59E-05	4.42E-05	4.34E-05

Table 59 - Waste generated per 1 kg Bend Connector for module A4.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	2.14E-06	1.83E-06	1.76E-06	1.67E-06	1.61E-06	1.58E-06
Non-hazardous waste disposed	kg	1.74E-02	1.49E-02	1.43E-02	1.36E-02	1.31E-02	1.28E-02
Radioactive waste disposed	kg	1.10E-05	9.38E-06	9.03E-06	8.57E-06	8.25E-06	8.10E-06

Table 60 - Output flows generated per 1 kg Bend Connector for module A4.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.5.3. Results for module A5 (Installation)

Table 61 - Environmental impacts per 1 kg Bend Connector for module A5.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	1.13E-01	6.39E-02	5.56E-02	4.27E-02	8.63E-02	6.55E-02
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	1.30E-03	8.85E-04	7.87E-04	6.68E-04	2.14E-03	1.61E-03
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	3.80E-05	2.22E-05	1.90E-05	1.46E-05	5.47E-05	3.97E-05
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**1.15E-01**	**6.48E-02**	**5.64E-02**	**4.34E-02**	**8.85E-02**	**6.71E-02**
Ozone depletion potential (ODP)	kg CFC 11 eq.	5.16E-09	3.20E-09	2.84E-09	2.31E-09	5.11E-09	3.94E-09
Acidification potential (AP)	mol H^+ eq.	7.79E-04	4.38E-04	3.75E-04	2.85E-04	5.35E-04	4.06E-04
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	2.01E-04	1.16E-04	9.91E-05	7.59E-05	1.56E-04	1.18E-04
Eutrophication, freshwater (EP - F)	kg P eq.	2.30E-05	1.28E-05	1.10E-05	8.33E-06	2.69E-05	1.95E-05
Eutrophication, marine (EP - M)	kg N eq.	2.34E-04	1.29E-04	1.08E-04	7.96E-05	1.19E-04	9.07E-05
Eutrophication, terrestrial (EP - T)	mol N eq.	2.34E-03	1.30E-03	1.09E-03	8.01E-04	1.22E-03	9.25E-04
Photochemical ozone formation (POCP)	kg NMVOC eq.	6.44E-04	3.57E-04	3.01E-04	2.22E-04	3.62E-04	2.75E-04
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	1.65E-06	1.04E-06	9.02E-07	7.33E-07	2.44E-06	1.80E-06
Abiotic depletion potential - Fossil (ADP - F)	MJ	1.12E+00	6.59E-01	5.85E-01	4.68E-01	9.77E-01	7.51E-01
Water depletion Potential (WDP)	m^3	1.05E-01	7.35E-02	6.67E-02	5.78E-02	6.33E-02	5.66E-02

Table 62 - Additional environmental impact per 1 kg Bend Connector for module A5.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	1.10E-01	6.18E-02	5.37E-02	4.12E-02	8.32E-02	6.31E-02
Particulate matter	disease incidence	7.49E-09	4.17E-09	3.48E-09	2.56E-09	6.23E-09	4.57E-09
Ionising radiation - human health	kBq U-235 eq	4.44E-03	2.50E-03	2.17E-03	1.66E-03	5.03E-03	3.69E-03
Eco-toxicity (freshwater)	CTUe	2.52E+00	1.37E+00	1.15E+00	8.31E-01	2.81E+00	2.01E+00
Human toxicity potential - cancer effects	CTUh	4.62E-10	2.37E-10	1.89E-10	1.26E-10	7.78E-10	5.38E-10
Human toxicity potential - non cancer effects	CTUh	2.12E-09	1.16E-09	9.70E-10	7.03E-10	2.64E-09	1.89E-09
Soil quality	dimensionless	3.67E-01	2.19E-01	1.92E-01	1.52E-01	4.21E-01	3.15E-01

Table 63 - Use of resources per 1 kg Bend Connector for module A5.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
PERE	MJ	1.19E-01	6.39E-02	5.37E-02	3.89E-02	1.58E-01	1.12E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	1.19E-01	6.39E-02	5.37E-02	3.89E-02	1.58E-01	1.12E-01
PENRE	MJ	1.20E+00	7.04E-01	6.25E-01	5.00E-01	1.04E+00	8.01E-01
PENRM	MJ.	7.88E-02	0.00E+00	6.54E-02	6.36E-02	6.12E-02	6.04E-02
PENRT	MJ	1.28E+00	7.04E-01	6.91E-01	5.64E-01	1.10E+00	8.62E-01
SM	kg	6.57E-03	0.00E+00	6.54E-03	6.57E-03	6.55E-03	6.56E-03
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.52E-04	1.68E-04	1.52E-04	1.31E-04	2.59E-04	2.06E-04

Table 64 - Waste generated per 1 kg Bend Connector for module A5.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	1.38E-06	7.98E-07	6.92E-07	5.36E-07	1.59E-06	1.18E-06
Non-hazardous waste disposed	kg	1.01E-01	5.75E-02	4.82E-02	3.60E-02	7.85E-02	5.84E-02
Radioactive waste disposed	kg	2.15E-06	1.29E-06	1.14E-06	9.17E-07	2.33E-06	1.76E-06

Table 65 - Output flows generated per 1 kg Bend Connector for module A5.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.5.4. Results for module C1 (Deconstruction and demolition)

Table 66 - Environmental impacts per 1 kg Bend Connector for module C1.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO2 eq.	2.62E-03	1.31E-03	1.03E-03	6.55E-04	4.00E-04	2.74E-04
Global warming potential - Biogenic (GWP - B)	kg CO2 eq.	2.28E-07	1.14E-07	8.93E-08	5.69E-08	3.48E-08	2.38E-08
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO2 eq.	1.18E-10	5.92E-11	4.64E-11	2.96E-11	1.81E-11	1.24E-11
Global warming potential - Total (GWP - T)	**kg CO2 eq.**	**2.62E-03**	**1.31E-03**	**1.03E-03**	**6.55E-04**	**4.00E-04**	**2.74E-04**
Ozone depletion potential (ODP)	kg CFC 11 eq.	4.60E-13	2.30E-13	1.81E-13	1.15E-13	7.03E-14	4.82E-14
Acidification potential (AP)	mol H+ eq.	7.69E-05	3.85E-05	3.02E-05	1.92E-05	1.17E-05	8.06E-06
Eutrophication, freshwater (EP - F)	kg PO43- eq.	1.31E-05	6.56E-06	5.15E-06	3.28E-06	2.00E-06	1.37E-06
Eutrophication, freshwater (EP - F)	kg P eq.	3.58E-09	1.79E-09	1.41E-09	8.96E-10	5.47E-10	3.75E-10
Eutrophication, marine (EP - M)	kg N eq.	3.91E-05	1.95E-05	1.53E-05	9.77E-06	5.97E-06	4.09E-06
Eutrophication, terrestrial (EP - T)	mol N eq.	4.28E-04	2.14E-04	1.68E-04	1.07E-04	6.53E-05	4.48E-05
Photochemical ozone formation (POCP)	kg NMVOC eq.	1.14E-04	5.69E-05	4.46E-05	2.84E-05	1.74E-05	1.19E-05
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	1.16E-10	5.82E-11	4.56E-11	2.91E-11	1.78E-11	1.22E-11
Abiotic depletion potential - Fossil (ADP - F)	MJ	1.10E-03	5.48E-04	4.30E-04	2.74E-04	1.67E-04	1.15E-04
Water depletion Potential (WDP)	m3	2.58E-03	1.29E-03	1.01E-03	6.45E-04	3.94E-04	2.70E-04

Table 67 - Additional environmental impact per 1 kg Bend Connector for module C1.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	2.54E-03	1.27E-03	9.94E-04	6.34E-04	3.87E-04	2.65E-04
Particulate matter	disease incidence	2.59E-09	1.29E-09	1.01E-09	6.46E-10	3.95E-10	2.71E-10
Ionising radiation - human health	kBq U-235 eq	3.21E-08	1.60E-08	1.26E-08	8.02E-09	4.90E-09	3.36E-09
Eco-toxicity (freshwater)	CTUe	6.00E-02	3.00E-02	2.35E-02	1.50E-02	9.16E-03	6.28E-03
Human toxicity potential - cancer effects	CTUh	5.21E-13	2.61E-13	2.04E-13	1.30E-13	7.96E-14	5.46E-14
Human toxicity potential - non cancer effects	CTUh	6.15E-11	3.08E-11	2.41E-11	1.54E-11	9.39E-12	6.44E-12
Soil quality	dimensionless	2.60E-04	1.30E-04	1.02E-04	6.50E-05	3.97E-05	2.72E-05

Table 68 - Use of resources per 1 kg Bend Connector for module C1.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
PERE	MJ	8.05E-05	4.03E-05	3.16E-05	2.01E-05	1.23E-05	8.43E-06
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	8.05E-05	4.03E-05	3.16E-05	2.01E-05	1.23E-05	8.43E-06
PENRE	MJ	1.10E-03	5.51E-04	4.32E-04	2.76E-04	1.68E-04	1.15E-04
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.10E-03	5.51E-04	4.32E-04	2.76E-04	1.68E-04	1.15E-04
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	1.74E-07	8.71E-08	6.83E-08	4.36E-08	2.66E-08	1.82E-08

Table 69 - Waste generated per 1 kg Bend Connector for module C1.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	3.84E-10	1.92E-10	1.51E-10	9.60E-11	5.86E-11	4.02E-11
Non-hazardous waste disposed	kg	5.96E-06	2.98E-06	2.34E-06	1.49E-06	9.10E-07	6.24E-07
Radioactive waste disposed	kg	6.85E-12	3.43E-12	2.69E-12	1.71E-12	1.05E-12	7.17E-13

Table 70 - Output flows generated per 1 kg Bend Connector for module C1.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.5.5. Results for module C2 (EoL transport)

Table 71 - Environmental impacts per 1 kg Bend Connector for module C2.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	9.11E-03	9.09E-03	9.08E-03	9.08E-03	9.14E-03	9.12E-03
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	1.07E-06	1.07E-06	1.07E-06	1.07E-06	1.07E-06	1.07E-06
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	4.32E-07	4.31E-07	4.31E-07	4.30E-07	4.33E-07	4.32E-07
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**9.11E-03**	**9.09E-03**	**9.08E-03**	**9.08E-03**	**9.14E-03**	**9.12E-03**
Ozone depletion potential (ODP)	kg CFC 11 eq.	1.45E-09	1.45E-09	1.44E-09	1.44E-09	1.45E-09	1.45E-09
Acidification potential (AP)	mol H^+ eq.	6.78E-05	6.77E-05	6.76E-05	6.76E-05	6.81E-05	6.79E-05
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	8.39E-06	8.37E-06	8.37E-06	8.36E-06	8.42E-06	8.40E-06
Eutrophication, freshwater (EP - F)	kg P eq.	3.52E-07	3.51E-07	3.51E-07	3.51E-07	3.54E-07	3.53E-07
Eutrophication, marine (EP - M)	kg N eq.	1.93E-05	1.93E-05	1.93E-05	1.93E-05	1.94E-05	1.93E-05
Eutrophication, terrestrial (EP - T)	mol N eq.	2.12E-04	2.11E-04	2.11E-04	2.11E-04	2.13E-04	2.12E-04
Photochemical ozone formation (POCP)	kg NMVOC eq.	6.72E-05	6.70E-05	6.70E-05	6.70E-05	6.74E-05	6.73E-05
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	5.72E-08	5.70E-08	5.70E-08	5.70E-08	5.74E-08	5.72E-08
Abiotic depletion potential - Fossil (ADP - F)	MJ	1.23E-01	1.23E-01	1.23E-01	1.23E-01	1.24E-01	1.24E-01
Water depletion Potential (WDP)	m^3	6.77E-02	6.76E-02	6.75E-02	6.75E-02	6.80E-02	6.78E-02

Table 72 - Additional environmental impact per 1 kg Bend Connector for module C2.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	8.93E-03	8.91E-03	8.91E-03	8.90E-03	8.96E-03	8.94E-03
Particulate matter	disease incidence	4.77E-10	4.75E-10	4.75E-10	4.75E-10	4.78E-10	4.77E-10
Ionising radiation - human health	kBq U-235 eq	8.56E-05	8.54E-05	8.54E-05	8.53E-05	8.59E-05	8.57E-05
Eco-toxicity (freshwater)	CTUe	7.52E-02	7.50E-02	7.50E-02	7.49E-02	7.54E-02	7.52E-02
Human toxicity potential - cancer effects	CTUh	2.47E-12	2.46E-12	2.46E-12	2.46E-12	2.48E-12	2.47E-12
Human toxicity potential - non cancer effects	CTUh	9.99E-11	9.97E-11	9.97E-11	9.96E-11	1.00E-10	1.00E-10
Soil quality	dimensionless	3.83E-02	3.82E-02	3.82E-02	3.82E-02	3.84E-02	3.83E-02

Table 73 - Use of resources per 1 kg Bend Connector for module C2.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
PERE	MJ	1.43E-03	1.42E-03	1.42E-03	1.42E-03	1.43E-03	1.43E-03
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	1.43E-03	1.42E-03	1.42E-03	1.42E-03	1.43E-03	1.43E-03
PENRE	MJ	1.30E-01	1.30E-01	1.30E-01	1.30E-01	1.31E-01	1.31E-01
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.30E-01	1.30E-01	1.30E-01	1.30E-01	1.31E-01	1.31E-01
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	1.41E-05	1.41E-05	1.41E-05	1.41E-05	1.42E-05	1.41E-05

Table 74 - Waste generated per 1 kg Bend Connector for module C2.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	1.90E-07	1.90E-07	1.90E-07	1.90E-07	1.91E-07	1.91E-07
Non-hazardous waste disposed	kg	1.54E-03	1.54E-03	1.54E-03	1.54E-03	1.55E-03	1.54E-03
Radioactive waste disposed	kg	1.08E-07	1.08E-07	1.08E-07	1.08E-07	1.09E-07	1.08E-07

Table 75 - Output flows generated per 1 kg Bend Connector for module C2.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.5.6. Results for module C3 (Waste processing)

Table 76 - Environmental impacts per 1 kg Bend Connector for module C3.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	5.06E-01	5.03E-01	5.02E-01	5.01E-01	5.11E-01	5.07E-01
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	5.01E-04	4.94E-04	4.93E-04	4.91E-04	5.12E-04	5.04E-04
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	8.30E-06	8.29E-06	8.29E-06	8.29E-06	8.31E-06	8.30E-06
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**5.07E-01**	**5.03E-01**	**5.03E-01**	**5.02E-01**	**5.12E-01**	**5.08E-01**
Ozone depletion potential (ODP)	kg CFC 11 eq.	4.02E-09	4.02E-09	4.02E-09	4.01E-09	4.04E-09	4.03E-09
Acidification potential (AP)	mol H^+ eq.	3.15E-03	3.12E-03	3.12E-03	3.11E-03	3.18E-03	3.15E-03
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	3.93E-04	3.92E-04	3.92E-04	3.91E-04	3.95E-04	3.94E-04
Eutrophication, freshwater (EP - F)	kg P eq.	1.25E-05	1.25E-05	1.25E-05	1.25E-05	1.26E-05	1.25E-05
Eutrophication, marine (EP - M)	kg N eq.	1.03E-03	1.03E-03	1.03E-03	1.03E-03	1.04E-03	1.03E-03
Eutrophication, terrestrial (EP - T)	mol N eq.	1.12E-02	1.12E-02	1.12E-02	1.12E-02	1.13E-02	1.13E-02
Photochemical ozone formation (POCP)	kg NMVOC eq.	2.77E-03	2.76E-03	2.76E-03	2.75E-03	2.78E-03	2.77E-03
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	4.87E-07	4.87E-07	4.86E-07	4.86E-07	4.89E-07	4.88E-07
Abiotic depletion potential - Fossil (ADP - F)	MJ	5.38E+00	5.36E+00	5.36E+00	5.35E+00	5.41E+00	5.39E+00
Water depletion Potential (WDP)	m^3	7.14E+00	7.06E+00	7.04E+00	7.02E+00	7.26E+00	7.17E+00

Table 77 - Additional environmental impact per 1 kg Bend Connector for module C3.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	4.89E-01	4.86E-01	4.85E-01	4.84E-01	4.94E-01	4.91E-01
Particulate matter	disease incidence	1.28E-08	1.27E-08	1.26E-08	1.26E-08	1.31E-08	1.29E-08
Ionising radiation - human health	kBq U-235 eq	7.69E-04	7.68E-04	7.68E-04	7.68E-04	7.70E-04	7.69E-04
Eco-toxicity (freshwater)	CTUe	1.18E+00	1.17E+00	1.16E+00	1.16E+00	1.19E+00	1.18E+00
Human toxicity potential - cancer effects	CTUh	6.24E-11	6.19E-11	6.18E-11	6.16E-11	6.31E-11	6.26E-11
Human toxicity potential - non cancer effects	CTUh	1.13E-09	1.12E-09	1.12E-09	1.12E-09	1.14E-09	1.13E-09
Soil quality	dimensionless	5.93E-01	5.85E-01	5.83E-01	5.81E-01	6.04E-01	5.96E-01

Table 78 - Use of resources per 1 kg Bend Connector for module C3.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
PERE	MJ	2.14E-01	2.11E-01	2.11E-01	2.10E-01	2.19E-01	2.16E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.14E-01	2.11E-01	2.11E-01	2.10E-01	2.19E-01	2.16E-01
PENRE	MJ	5.40E+00	5.38E+00	5.38E+00	5.37E+00	5.43E+00	5.41E+00
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	5.40E+00	5.38E+00	5.38E+00	5.37E+00	5.43E+00	5.41E+00
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	5.69E-03	5.68E-03	5.68E-03	5.68E-03	5.69E-03	5.69E-03

Table 79 - Waste generated per 1 kg Bend Connector for module C3.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	7.28E-07	7.22E-07	7.21E-07	7.20E-07	7.36E-07	7.30E-07
Non-hazardous waste disposed	kg	3.03E-01	3.02E-01	3.02E-01	3.02E-01	3.03E-01	3.03E-01
Radioactive waste disposed	kg	2.42E-07	2.41E-07	2.41E-07	2.41E-07	2.42E-07	2.42E-07

Table 80 - Output flows generated per 1 kg Bend Connector for module C3.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	2.01E+00	4.01E+00	5.11E+00	8.01E+00	1.32E+01	1.92E+01
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.5.7. Results for module C4[18] (Disposal)

Table 81 - Environmental impacts per 1 kg Bend Connector for module C4.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ozone depletion potential (ODP)	kg CFC 11 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acidification potential (AP)	mol H^+ eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eutrophication, freshwater (EP - F)	kg P eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eutrophication, marine (EP - M)	kg N eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eutrophication, terrestrial (EP - T)	mol N eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Photochemical ozone formation (POCP)	kg NMVOC eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Abiotic depletion potential - Fossil (ADP - F)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Water depletion Potential (WDP)	m^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

[18] Environmental impacts for C4 module are zero as there will be no landfilling for Scenario 1.

Table 82 - Additional environmental impact per 1 kg Bend Connector for module C4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Particulate matter	disease incidence	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ionising radiation - human health	kBq U-235 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eco-toxicity (freshwater)	CTUe	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Human toxicity potential - cancer effects	CTUh	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Human toxicity potential - non cancer effects	CTUh	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Soil quality	dimensionless	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 83 - Use of resources per 1 kg Bend Connector for module C4.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
PERE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 84 - Waste generated per 1 kg Bend Connector for modules C4.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-hazardous waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 85 - Output flows generated per 1 kg Bend Connector for modules C4.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.5.8. Results for module D (recycling benefits beyond the system boundary)

Table 86 - Environmental impacts per 1 kg Bend Connector for module D.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	-1.61E+00	-1.61E+00	-1.61E+00	-1.61E+00	-1.62E+00	-1.62E+00
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	-8.34E-03	-8.34E-03	-8.34E-03	-8.35E-03	-8.32E-03	-8.33E-03
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	-4.95E-04	-4.93E-04	-4.92E-04	-4.92E-04	-4.98E-04	-4.96E-04
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	-1.62E+00	-1.62E+00	-1.62E+00	-1.61E+00	-1.63E+00	-1.62E+00
Ozone depletion potential (ODP)	kg CFC 11 eq.	-4.13E-08	-4.11E-08	-4.10E-08	-4.10E-08	-4.17E-08	-4.14E-08
Acidification potential (AP)	mol H^+ eq.	-5.81E-03	-5.79E-03	-5.78E-03	-5.77E-03	-5.85E-03	-5.82E-03
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	-1.22E-03	-1.20E-03	-1.20E-03	-1.19E-03	-1.24E-03	-1.22E-03
Eutrophication, freshwater (EP - F)	kg P eq.	-2.66E-04	-2.63E-04	-2.62E-04	-2.61E-04	-2.72E-04	-2.68E-04
Eutrophication, marine (EP - M)	kg N eq.	-1.04E-03	-1.04E-03	-1.04E-03	-1.04E-03	-1.05E-03	-1.05E-03
Eutrophication, terrestrial (EP - T)	mol N eq.	-1.11E-02	-1.10E-02	-1.10E-02	-1.10E-02	-1.12E-02	-1.11E-02
Photochemical ozone formation (POCP)	kg NMVOC eq.	-5.41E-03	-5.38E-03	-5.37E-03	-5.37E-03	-5.45E-03	-5.42E-03
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	-1.45E-05	-1.44E-05	-1.44E-05	-1.44E-05	-1.47E-05	-1.46E-05
Abiotic depletion potential - Fossil (ADP - F)	MJ	-5.67E+01	-5.67E+01	-5.67E+01	-5.67E+01	-5.68E+01	-5.68E+01
Water depletion Potential (WDP)	m^3	-1.29E+00	-1.29E+00	-1.29E+00	-1.29E+00	-1.29E+00	-1.29E+00

Table 87 - Additional environmental impact per 1 kg Bend Connector for module D.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	-1.50E+00	-1.50E+00	-1.50E+00	-1.49E+00	-1.51E+00	-1.50E+00
Particulate matter	disease incidence	-4.89E-08	-4.85E-08	-4.84E-08	-4.82E-08	-4.96E-08	-4.91E-08
Ionising radiation - human health	kBq U-235 eq	-1.08E-01	-1.08E-01	-1.08E-01	-1.07E-01	-1.08E-01	-1.08E-01
Eco-toxicity (freshwater)	CTUe	-9.51E+00	-9.24E+00	-9.18E+00	-9.10E+00	-9.92E+00	-9.62E+00
Human toxicity potential - cancer effects	CTUh	-5.11E-10	-4.67E-10	-4.57E-10	-4.44E-10	-5.78E-10	-5.29E-10
Human toxicity potential - non cancer effects	CTUh	-1.07E-08	-1.05E-08	-1.04E-08	-1.04E-08	-1.09E-08	-1.07E-08
Soil quality	dimensionless	-1.89E+00	-1.87E+00	-1.86E+00	-1.86E+00	-1.92E+00	-1.89E+00

Table 88 - Use of resources per 1 kg Bend Connector for module D.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
PERE	MJ	-9.61E-01	-9.55E-01	-9.54E-01	-9.53E-01	-9.69E-01	-9.63E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	-9.61E-01	-9.55E-01	-9.54E-01	-9.53E-01	-9.69E-01	-9.63E-01
PENRE	MJ	-6.09E+01	-6.08E+01	-6.08E+01	-6.08E+01	-6.10E+01	-6.09E+01
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	-6.09E+01	-6.08E+01	-6.08E+01	-6.08E+01	-6.10E+01	-6.09E+01
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	-1.01E-02	-1.01E-02	-1.01E-02	-1.01E-02	-1.01E-02	-1.01E-02

Table 89 - Waste generated per 1 kg Bend Connector for module D.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	-7.61E-06	-7.23E-06	-7.15E-06	-7.05E-06	-8.18E-06	-7.76E-06
Non-hazardous waste disposed	kg	-5.65E-02	-5.42E-02	-5.37E-02	-5.31E-02	-5.99E-02	-5.74E-02
Radioactive waste disposed	kg	-3.39E-05	-3.38E-05	-3.37E-05	-3.37E-05	-3.40E-05	-3.39E-05

Table 90 - Output flows generated per 1 kg Bend Connector for module D.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.6. Environmental performance results for Bend series – Landfilling at EoL scenario

All results except those for modules C3, C4 and D are same for the landfilling and recycling at EoL scenario. For the landfilling scenario module C3 and D will have zero impact, whereas the results for module C4 are provided below:

6.6.1. Results for module C4 (Disposal)

Table 91 - Environmental impacts per 1 kg Bend Connector for module C4.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	3.26E-02	3.25E-02	3.25E-02	3.25E-02	3.26E-02	3.26E-02
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	1.24E-05	1.24E-05	1.24E-05	1.24E-05	1.24E-05	1.24E-05
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	8.87E-07	8.87E-07	8.87E-07	8.87E-07	8.88E-07	8.88E-07
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**3.26E-02**	**3.26E-02**	**3.25E-02**	**3.25E-02**	**3.26E-02**	**3.26E-02**
Ozone depletion potential (ODP)	kg CFC 11 eq.	2.22E-09	2.22E-09	2.22E-09	2.21E-09	2.23E-09	2.23E-09
Acidification potential (AP)	mol H^+ eq.	1.53E-04	1.53E-04	1.53E-04	1.53E-04	1.53E-04	1.53E-04
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	6.15E-04	6.15E-04	6.15E-04	6.15E-04	6.15E-04	6.15E-04
Eutrophication, freshwater (EP - F)	kg P eq.	8.36E-07	8.35E-07	8.35E-07	8.35E-07	8.36E-07	8.36E-07
Eutrophication, marine (EP - M)	kg N eq.	3.09E-04	3.09E-04	3.09E-04	3.09E-04	3.09E-04	3.09E-04
Eutrophication, terrestrial (EP - T)	mol N eq.	4.96E-04	4.96E-04	4.96E-04	4.96E-04	4.96E-04	4.96E-04
Photochemical ozone formation (POCP)	kg NMVOC eq.	1.49E-04	1.49E-04	1.49E-04	1.49E-04	1.49E-04	1.49E-04
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	8.61E-08	8.61E-08	8.61E-08	8.61E-08	8.62E-08	8.61E-08
Abiotic depletion potential - Fossil (ADP - F)	MJ	2.11E-01	2.10E-01	2.10E-01	2.10E-01	2.11E-01	2.11E-01
Water depletion Potential (WDP)	m^3	1.86E-01	1.86E-01	1.86E-01	1.86E-01	1.86E-01	1.86E-01

Table 92 - Additional environmental impact per 1 kg Bend Connector for module C4.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	2.86E-02	2.86E-02	2.86E-02	2.86E-02	2.86E-02	2.86E-02
Particulate matter	disease incidence	1.10E-09	1.10E-09	1.10E-09	1.10E-09	1.10E-09	1.10E-09
Ionising radiation - human health	kBq U-235 eq	1.65E-04	1.65E-04	1.65E-04	1.65E-04	1.65E-04	1.65E-04
Eco-toxicity (freshwater)	CTUe	2.46E-01	2.46E-01	2.46E-01	2.46E-01	2.46E-01	2.46E-01
Human toxicity potential - cancer effects	CTUh	6.25E-12	6.24E-12	6.24E-12	6.24E-12	6.25E-12	6.25E-12
Human toxicity potential - non cancer effects	CTUh	2.37E-10	2.37E-10	2.37E-10	2.37E-10	2.37E-10	2.37E-10
Soil quality	dimensionless	1.55E-01	1.54E-01	1.54E-01	1.54E-01	1.56E-01	1.55E-01

Table 93 - Use of resources per 1 kg Bend Connector for module C4.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
PERE	MJ	3.49E-03	3.49E-03	3.49E-03	3.49E-03	3.49E-03	3.49E-03
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	3.49E-03	3.49E-03	3.49E-03	3.49E-03	3.49E-03	3.49E-03
PENRE	MJ	2.22E-01	2.22E-01	2.22E-01	2.22E-01	2.23E-01	2.22E-01
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.22E-01	2.22E-01	2.22E-01	2.22E-01	2.23E-01	2.22E-01
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	5.08E-05	5.06E-05	5.06E-05	5.05E-05	5.12E-05	5.09E-05

Table 94 - Waste generated per 1 kg Bend Connector for module C4.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	3.18E-07	3.17E-07	3.17E-07	3.17E-07	3.18E-07	3.18E-07
Non-hazardous waste disposed	kg	9.63E-01	9.60E-01	9.60E-01	9.59E-01	9.66E-01	9.64E-01
Radioactive waste disposed	kg	1.90E-07	1.90E-07	1.90E-07	1.90E-07	1.91E-07	1.90E-07

Table 95 - Output flows generated per 1 kg Bend Connector for module C4.

Indicator	Unit	Bend Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.7. Environmental performance results for Bend series – Leaving the ducts ‘as is’ at EoL scenario

All results except those for modules C1-C4, and D are same for this scenario and recycling at EoL. Impacts for C1-C4 and D will be zero in this case.

6.8. Environmental performance results for Tee series – Recycling at EoL scenario

6.8.1. Results for modules A1-A3 (Manufacturing stage)

Table 96 - Environmental impacts per 1 kg Tee Connector for modules A1-A3.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	2.40E+00	2.20E+00	2.22E+00	1.91E+00	1.70E+00	1.61E+00
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	4.19E-02	4.28E-02	4.27E-02	4.39E-02	4.48E-02	4.52E-02
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	7.26E-04	7.00E-04	6.97E-04	6.65E-04	6.42E-04	6.32E-04
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**2.44E+00**	**2.24E+00**	**2.26E+00**	**1.95E+00**	**1.74E+00**	**1.65E+00**
Ozone depletion potential (ODP)	kg CFC 11 eq.	1.37E-07	1.32E-07	1.32E-07	1.23E-07	1.17E-07	1.14E-07
Acidification potential (AP)	mol H^+ eq.	1.21E-02	1.11E-02	1.12E-02	9.61E-03	8.56E-03	8.10E-03
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	3.44E-03	3.26E-03	3.27E-03	3.00E-03	2.81E-03	2.73E-03
Eutrophication, freshwater (EP - F)	kg P eq.	5.02E-04	4.63E-04	4.65E-04	4.05E-04	3.64E-04	3.47E-04
Eutrophication, marine (EP - M)	kg N eq.	2.19E-03	2.04E-03	2.05E-03	1.80E-03	1.64E-03	1.57E-03
Eutrophication, terrestrial (EP - T)	mol N eq.	2.29E-02	2.12E-02	2.13E-02	1.87E-02	1.70E-02	1.63E-02
Photochemical ozone formation (POCP)	kg NMVOC eq.	7.07E-03	6.56E-03	6.58E-03	5.81E-03	5.28E-03	5.05E-03
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	4.29E-05	4.25E-05	4.23E-05	4.19E-05	4.17E-05	4.16E-05
Abiotic depletion potential - Fossil (ADP - F)	MJ	3.18E+01	2.93E+01	2.93E+01	2.55E+01	2.28E+01	2.17E+01
Water depletion Potential (WDP)	m^3	5.60E-01	5.32E-01	5.27E-01	4.91E-01	4.66E-01	4.55E-01

Table 97 - Additional environmental impact per 1 kg Tee Connector for modules A1-A3.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	2.31E+00	2.12E+00	2.13E+00	1.83E+00	1.63E+00	1.54E+00
Particulate matter	disease incidence	9.46E-08	9.14E-08	9.13E-08	8.66E-08	8.34E-08	8.20E-08
Ionising radiation - human health	kBq U-235 eq	1.02E-01	9.36E-02	9.40E-02	8.21E-02	7.40E-02	7.04E-02
Eco-toxicity (freshwater)	CTUe	3.35E+01	3.16E+01	3.17E+01	2.87E+01	2.66E+01	2.57E+01
Human toxicity potential - cancer effects	CTUh	1.48E-09	1.43E-09	1.43E-09	1.35E-09	1.30E-09	1.28E-09
Human toxicity potential - non cancer effects	CTUh	2.65E-08	2.53E-08	2.54E-08	2.36E-08	2.23E-08	2.18E-08
Soil quality	dimensionless	9.10E+00	8.65E+00	8.66E+00	7.99E+00	7.53E+00	7.33E+00

Table 98 - Use of resources per 1 kg Tee Connector for modules A1-A3.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
PERE	MJ	1.74E+00	1.59E+00	1.60E+00	1.37E+00	1.21E+00	1.15E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	1.74E+00	1.59E+00	1.60E+00	1.37E+00	1.21E+00	1.15E+00
PENRE	MJ	3.42E+01	3.15E+01	3.15E+01	2.74E+01	2.45E+01	2.33E+01
PENRM	MJ.	6.53E+00	6.36E+00	6.24E+00	6.12E+00	6.02E+00	5.98E+00
PENRT	MJ	4.08E+01	3.78E+01	3.78E+01	3.35E+01	3.06E+01	2.93E+01
SM	kg	6.57E-01	6.57E-01	6.55E-01	6.55E-01	6.56E-01	6.57E-01
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	7.73E-03	7.34E-03	7.29E-03	6.76E-03	6.39E-03	6.23E-03

Table 99 - Waste generated per 1 kg Tee Connector for modules A1-A3.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	3.06E-05	2.89E-05	2.90E-05	2.63E-05	2.45E-05	2.37E-05
Non-hazardous waste disposed	kg	3.26E-01	3.19E-01	3.18E-01	3.10E-01	3.04E-01	3.01E-01
Radioactive waste disposed	kg	5.73E-05	5.38E-05	5.41E-05	4.88E-05	4.52E-05	4.37E-05

Table 100 - Output flows generated per 1 kg Tee Connector for modules A1-A3.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.8.2. Results for Moulde A4 (Transport)

Table 101 - Environmental impacts per 1 kg Tee Connector for module A4[19].

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	1.07E-01	1.03E-01	1.02E-01	9.97E-02	9.74E-02	9.61E-02
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	-1.65E-05	-1.60E-05	-1.58E-05	-1.54E-05	-1.51E-05	-1.49E-05
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	6.22E-05	6.03E-05	5.96E-05	5.81E-05	5.67E-05	5.60E-05
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**1.07E-01**	**1.04E-01**	**1.02E-01**	**9.97E-02**	**9.75E-02**	**9.62E-02**
Ozone depletion potential (ODP)	kg CFC 11 eq.	2.13E-08	2.07E-08	2.04E-08	1.99E-08	1.95E-08	1.92E-08
Acidification potential (AP)	mol H^+ eq.	2.82E-03	2.73E-03	2.70E-03	2.63E-03	2.57E-03	2.54E-03
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	2.60E-04	2.52E-04	2.49E-04	2.43E-04	2.37E-04	2.34E-04
Eutrophication, freshwater (EP - F)	kg P eq.	4.64E-06	4.50E-06	4.44E-06	4.33E-06	4.23E-06	4.18E-06
Eutrophication, marine (EP - M)	kg N eq.	6.99E-04	6.77E-04	6.70E-04	6.53E-04	6.38E-04	6.29E-04
Eutrophication, terrestrial (EP - T)	mol N eq.	7.76E-03	7.52E-03	7.43E-03	7.24E-03	7.08E-03	6.99E-03
Photochemical ozone formation (POCP)	kg NMVOC eq.	2.03E-03	1.97E-03	1.95E-03	1.90E-03	1.86E-03	1.83E-03
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	1.04E-06	1.01E-06	1.00E-06	9.75E-07	9.53E-07	9.41E-07
Abiotic depletion potential - Fossil (ADP - F)	MJ	1.40E+00	1.36E+00	1.35E+00	1.31E+00	1.28E+00	1.26E+00
Water depletion Potential (WDP)	m^3	8.32E-02	8.06E-02	7.97E-02	7.76E-02	7.59E-02	7.49E-02

[19] The negative biogenic carbon value is a result of the background process for sea transport using container ships. The main contributor for this is the wood (softwood, glued laminated timer etc.) used for maintenance of the ship. Please refer to the appendix for the network diagram explaining this.

Table 102 - Additional environmental impact per 1 kg Tee Connector for module A4.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	1.06E-01	1.03E-01	1.01E-01	9.87E-02	9.65E-02	9.52E-02
Particulate matter	disease incidence	4.04E-09	3.92E-09	3.88E-09	3.78E-09	3.69E-09	3.64E-09
Ionising radiation - human health	kBq U-235 eq	5.92E-03	5.74E-03	5.67E-03	5.53E-03	5.40E-03	5.33E-03
Eco-toxicity (freshwater)	CTUe	9.30E-01	9.02E-01	8.92E-01	8.69E-01	8.49E-01	8.38E-01
Human toxicity potential - cancer effects	CTUh	5.42E-11	5.26E-11	5.20E-11	5.06E-11	4.95E-11	4.88E-11
Human toxicity potential - non cancer effects	CTUh	8.40E-10	8.15E-10	8.05E-10	7.85E-10	7.67E-10	7.57E-10
Soil quality	dimensionless	3.27E-01	3.17E-01	3.14E-01	3.06E-01	2.99E-01	2.95E-01

Table 103 - Use of resources per 1 kg Tee Connector for module A4.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
PERE	MJ	1.17E-02	1.13E-02	1.12E-02	1.09E-02	1.06E-02	1.05E-02
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	1.17E-02	1.13E-02	1.12E-02	1.09E-02	1.06E-02	1.05E-02
PENRE	MJ	1.49E+00	1.44E+00	1.43E+00	1.39E+00	1.36E+00	1.34E+00
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.49E+00	1.44E+00	1.43E+00	1.39E+00	1.36E+00	1.34E+00
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	4.74E-05	4.59E-05	4.54E-05	4.42E-05	4.32E-05	4.27E-05

Table 104 - Waste generated per 1 kg Tee Connector for module A4.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	1.72E-06	1.67E-06	1.65E-06	1.61E-06	1.57E-06	1.55E-06
Non-hazardous waste disposed	kg	1.40E-02	1.36E-02	1.34E-02	1.31E-02	1.28E-02	1.26E-02
Radioactive waste disposed	kg	8.84E-06	8.57E-06	8.47E-06	8.25E-06	8.06E-06	7.96E-06

Table 105 - Output flows generated per 1 kg Tee Connector for module A4.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.8.3. Results for module A5 (Installation)

Table 106 - Environmental impacts per 1 kg Tee Connector for module A5.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	4.64E-02	3.97E-02	3.82E-02	3.11E-02	5.91E-02	4.47E-02
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	7.43E-04	6.72E-04	6.42E-04	5.89E-04	1.50E-03	1.15E-03
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	1.70E-05	1.44E-05	1.36E-05	1.14E-05	3.65E-05	2.63E-05
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**4.71E-02**	**4.04E-02**	**3.89E-02**	**3.17E-02**	**6.06E-02**	**4.59E-02**
Ozone depletion potential (ODP)	kg CFC 11 eq.	2.53E-09	2.24E-09	2.16E-09	1.88E-09	3.65E-09	2.85E-09
Acidification potential (AP)	mol H^+ eq.	3.16E-04	2.68E-04	2.55E-04	2.07E-04	3.68E-04	2.79E-04
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	8.44E-05	7.20E-05	6.82E-05	5.65E-05	1.07E-04	8.14E-05
Eutrophication, freshwater (EP - F)	kg P eq.	9.47E-06	7.99E-06	7.63E-06	6.14E-06	1.78E-05	1.28E-05
Eutrophication, marine (EP - M)	kg N eq.	9.03E-05	7.49E-05	7.00E-05	5.59E-05	8.14E-05	6.20E-05
Eutrophication, terrestrial (EP - T)	mol N eq.	9.13E-04	7.57E-04	7.08E-04	5.66E-04	8.34E-04	6.35E-04
Photochemical ozone formation (POCP)	kg NMVOC eq.	2.53E-04	2.11E-04	1.98E-04	1.58E-04	2.48E-04	1.88E-04
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	8.30E-07	7.30E-07	6.92E-07	6.10E-07	1.67E-06	1.25E-06
Abiotic depletion potential - Fossil (ADP - F)	MJ	4.94E-01	4.35E-01	4.23E-01	3.55E-01	6.82E-01	5.26E-01
Water depletion Potential (WDP)	m^3	3.83E-02	3.93E-02	3.96E-02	3.72E-02	4.12E-02	3.58E-02

Table 107 - Additional environmental impact per 1 kg Tee Connector for module A5.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	4.48E-02	3.84E-02	3.69E-02	3.00E-02	5.70E-02	4.31E-02
Particulate matter	disease incidence	3.02E-09	2.50E-09	2.32E-09	1.87E-09	4.18E-09	3.05E-09
Ionising radiation - human health	kBq U-235 eq	1.88E-03	1.60E-03	1.53E-03	1.25E-03	3.38E-03	2.46E-03
Eco-toxicity (freshwater)	CTUe	9.92E-01	8.12E-01	7.55E-01	5.95E-01	1.83E+00	1.29E+00
Human toxicity potential - cancer effects	CTUh	1.62E-10	1.25E-10	1.12E-10	8.14E-11	4.88E-10	3.26E-10
Human toxicity potential - non cancer effects	CTUh	8.42E-10	6.90E-10	6.40E-10	5.08E-10	1.72E-09	1.21E-09
Soil quality	dimensionless	1.67E-01	1.46E-01	1.40E-01	1.19E-01	2.88E-01	2.16E-01

Table 108 - Use of resources per 1 kg Tee Connector for module A5.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
PERE	MJ	4.54E-02	3.72E-02	3.49E-02	2.71E-02	1.02E-01	7.07E-02
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	4.54E-02	3.72E-02	3.49E-02	2.71E-02	1.02E-01	7.07E-02
PENRE	MJ	5.28E-01	4.65E-01	4.53E-01	3.80E-01	7.27E-01	5.61E-01
PENRM	MJ.	6.53E-02	6.36E-02	6.24E-02	6.12E-02	6.02E-02	5.98E-02
PENRT	MJ	5.93E-01	5.28E-01	5.15E-01	4.41E-01	7.87E-01	6.21E-01
SM	kg	6.57E-03	6.57E-03	6.55E-03	6.55E-03	6.56E-03	6.57E-03
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	1.21E-04	1.14E-04	1.12E-04	1.01E-04	1.83E-04	1.46E-04

Table 109 - Waste generated per 1 kg Tee Connector for module A5.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	6.05E-07	5.19E-07	4.95E-07	4.12E-07	1.08E-06	7.93E-07
Non-hazardous waste disposed	kg	3.56E-02	3.03E-02	2.84E-02	2.31E-02	4.99E-02	3.61E-02
Radioactive waste disposed	kg	1.01E-06	8.89E-07	8.58E-07	7.33E-07	1.62E-06	1.24E-06

Table 110 - Output flows generated per 1 kg Tee Connector for module A5.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.8.4. Results for module C1 (Deconstruction and demolition)

Table 111 - Environmental impacts per 1 kg Tee Connector for module C1.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	8.73E-04	6.55E-04	5.75E-04	4.00E-04	2.48E-04	1.64E-04
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	7.59E-08	5.69E-08	5.00E-08	3.48E-08	2.16E-08	1.42E-08
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	3.94E-11	2.96E-11	2.60E-11	1.81E-11	1.12E-11	7.40E-12
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**8.73E-04**	**6.55E-04**	**5.75E-04**	**4.00E-04**	**2.48E-04**	**1.64E-04**
Ozone depletion potential (ODP)	kg CFC 11 eq.	1.53E-13	1.15E-13	1.01E-13	7.03E-14	4.36E-14	2.88E-14
Acidification potential (AP)	mol H^+ eq.	2.56E-05	1.92E-05	1.69E-05	1.17E-05	7.29E-06	4.81E-06
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	4.37E-06	3.28E-06	2.88E-06	2.00E-06	1.24E-06	8.20E-07
Eutrophication, freshwater (EP - F)	kg P eq.	1.19E-09	8.96E-10	7.88E-10	5.47E-10	3.40E-10	2.24E-10
Eutrophication, marine (EP - M)	kg N eq.	1.30E-05	9.77E-06	8.59E-06	5.97E-06	3.70E-06	2.44E-06
Eutrophication, terrestrial (EP - T)	mol N eq.	1.43E-04	1.07E-04	9.40E-05	6.53E-05	4.05E-05	2.67E-05
Photochemical ozone formation (POCP)	kg NMVOC eq.	3.79E-05	2.84E-05	2.50E-05	1.74E-05	1.08E-05	7.11E-06
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	3.88E-11	2.91E-11	2.56E-11	1.78E-11	1.10E-11	7.27E-12
Abiotic depletion potential - Fossil (ADP - F)	MJ	3.66E-04	2.74E-04	2.41E-04	1.67E-04	1.04E-04	6.85E-05
Water depletion Potential (WDP)	m^3	8.60E-04	6.45E-04	5.67E-04	3.94E-04	2.45E-04	1.61E-04

Table 112 - Additional environmental impact per 1 kg Tee Connector for module C1.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	8.45E-04	6.34E-04	5.57E-04	3.87E-04	2.40E-04	1.58E-04
Particulate matter	disease incidence	8.62E-10	6.46E-10	5.68E-10	3.95E-10	2.45E-10	1.62E-10
Ionising radiation - human health	kBq U-235 eq	1.07E-08	8.02E-09	7.05E-09	4.90E-09	3.04E-09	2.01E-09
Eco-toxicity (freshwater)	CTUe	2.00E-02	1.50E-02	1.32E-02	9.16E-03	5.68E-03	3.75E-03
Human toxicity potential - cancer effects	CTUh	1.74E-13	1.30E-13	1.15E-13	7.96E-14	4.94E-14	3.26E-14
Human toxicity potential - non cancer effects	CTUh	2.05E-11	1.54E-11	1.35E-11	9.39E-12	5.83E-12	3.85E-12
Soil quality	dimensionless	8.67E-05	6.50E-05	5.71E-05	3.97E-05	2.46E-05	1.63E-05

Table 113 - Use of resources per 1 kg Tee Connector for module C1.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
PERE	MJ	2.68E-05	2.01E-05	1.77E-05	1.23E-05	7.63E-06	5.03E-06
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.68E-05	2.01E-05	1.77E-05	1.23E-05	7.63E-06	5.03E-06
PENRE	MJ	3.67E-04	2.76E-04	2.42E-04	1.68E-04	1.04E-04	6.89E-05
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	3.67E-04	2.76E-04	2.42E-04	1.68E-04	1.04E-04	6.89E-05
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	5.81E-08	4.36E-08	3.83E-08	2.66E-08	1.65E-08	1.09E-08

Table 114 - Waste generated per 1 kg Tee Connector for module C1.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	1.28E-10	9.60E-11	8.44E-11	5.86E-11	3.64E-11	2.40E-11
Non-hazardous waste disposed	kg	1.99E-06	1.49E-06	1.31E-06	9.10E-07	5.65E-07	3.73E-07
Radioactive waste disposed	kg	2.28E-12	1.71E-12	1.51E-12	1.05E-12	6.49E-13	4.28E-13

Table 115 - Output flows generated per 1 kg Tee Connector for module C1.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.8.5. Results for module C2 (EoL transport)

Table 116 - Environmental impacts per 1 kg Tee Connector for module C2.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	9.08E-03	9.08E-03	9.07E-03	9.07E-03	9.11E-03	9.10E-03
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	1.07E-06	1.07E-06	1.07E-06	1.07E-06	1.07E-06	1.07E-06
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	4.30E-07	4.30E-07	4.30E-07	4.30E-07	4.32E-07	4.31E-07
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**9.08E-03**	**9.08E-03**	**9.08E-03**	**9.07E-03**	**9.11E-03**	**9.10E-03**
Ozone depletion potential (ODP)	kg CFC 11 eq.	1.44E-09	1.44E-09	1.44E-09	1.44E-09	1.45E-09	1.45E-09
Acidification potential (AP)	mol H^+ eq.	6.76E-05	6.76E-05	6.76E-05	6.76E-05	6.79E-05	6.77E-05
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	8.37E-06	8.36E-06	8.36E-06	8.36E-06	8.40E-06	8.38E-06
Eutrophication, freshwater (EP - F)	kg P eq.	3.51E-07	3.51E-07	3.51E-07	3.51E-07	3.52E-07	3.52E-07
Eutrophication, marine (EP - M)	kg N eq.	1.93E-05	1.93E-05	1.93E-05	1.93E-05	1.93E-05	1.93E-05
Eutrophication, terrestrial (EP - T)	mol N eq.	2.11E-04	2.11E-04	2.11E-04	2.11E-04	2.12E-04	2.12E-04
Photochemical ozone formation (POCP)	kg NMVOC eq.	6.70E-05	6.70E-05	6.70E-05	6.69E-05	6.72E-05	6.71E-05
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	5.70E-08	5.70E-08	5.70E-08	5.69E-08	5.72E-08	5.71E-08
Abiotic depletion potential - Fossil (ADP - F)	MJ	1.23E-01	1.23E-01	1.23E-01	1.23E-01	1.23E-01	1.23E-01
Water depletion Potential (WDP)	m^3	6.75E-02	6.75E-02	6.75E-02	6.75E-02	6.77E-02	6.76E-02

Table 117 - Additional environmental impact per 1 kg Tee Connector for module C2.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	8.90E-03	8.90E-03	8.90E-03	8.90E-03	8.93E-03	8.92E-03
Particulate matter	disease incidence	4.75E-10	4.75E-10	4.75E-10	4.75E-10	4.77E-10	4.76E-10
Ionising radiation - human health	kBq U-235 eq	8.53E-05	8.53E-05	8.53E-05	8.53E-05	8.56E-05	8.55E-05
Eco-toxicity (freshwater)	CTUe	7.49E-02	7.49E-02	7.49E-02	7.49E-02	7.52E-02	7.51E-02
Human toxicity potential - cancer effects	CTUh	2.46E-12	2.46E-12	2.46E-12	2.46E-12	2.47E-12	2.47E-12
Human toxicity potential - non cancer effects	CTUh	9.96E-11	9.96E-11	9.96E-11	9.96E-11	1.00E-10	9.98E-11
Soil quality	dimensionless	3.82E-02	3.82E-02	3.81E-02	3.81E-02	3.83E-02	3.82E-02

Table 118 - Use of resources per 1 kg Tee Connector for module C2.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
PERE	MJ	1.42E-03	1.42E-03	1.42E-03	1.42E-03	1.43E-03	1.43E-03
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	1.42E-03	1.42E-03	1.42E-03	1.42E-03	1.43E-03	1.43E-03
PENRE	MJ	1.30E-01	1.30E-01	1.30E-01	1.30E-01	1.30E-01	1.30E-01
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.30E-01	1.30E-01	1.30E-01	1.30E-01	1.30E-01	1.30E-01
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	1.41E-05	1.41E-05	1.41E-05	1.40E-05	1.41E-05	1.41E-05

Table 119 - Waste generated per 1 kg Tee Connector for module C2.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	1.90E-07	1.90E-07	1.90E-07	1.90E-07	1.90E-07	1.90E-07
Non-hazardous waste disposed	kg	1.54E-03	1.54E-03	1.54E-03	1.54E-03	1.54E-03	1.54E-03
Radioactive waste disposed	kg	1.08E-07	1.08E-07	1.08E-07	1.08E-07	1.08E-07	1.08E-07

Table 120 - Output flows generated per 1 kg Tee Connector for module C2.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.8.6. Results for module C3 (Waste processing)

Table 121 - Environmental impacts per 1 kg Tee Connector for module C3.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	5.02E-01	5.01E-01	5.01E-01	5.00E-01	5.07E-01	5.04E-01
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	4.92E-04	4.91E-04	4.90E-04	4.89E-04	5.02E-04	4.97E-04
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	8.29E-06	8.29E-06	8.29E-06	8.29E-06	8.30E-06	8.30E-06
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**5.02E-01**	**5.02E-01**	**5.01E-01**	**5.01E-01**	**5.07E-01**	**5.05E-01**
Ozone depletion potential (ODP)	kg CFC 11 eq.	4.01E-09	4.01E-09	4.01E-09	4.01E-09	4.03E-09	4.02E-09
Acidification potential (AP)	mol H^+ eq.	3.12E-03	3.11E-03	3.11E-03	3.11E-03	3.15E-03	3.13E-03
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	3.91E-04	3.91E-04	3.91E-04	3.91E-04	3.94E-04	3.92E-04
Eutrophication, freshwater (EP - F)	kg P eq.	1.25E-05	1.25E-05	1.25E-05	1.25E-05	1.25E-05	1.25E-05
Eutrophication, marine (EP - M)	kg N eq.	1.03E-03	1.03E-03	1.02E-03	1.02E-03	1.03E-03	1.03E-03
Eutrophication, terrestrial (EP - T)	mol N eq.	1.12E-02	1.12E-02	1.12E-02	1.12E-02	1.12E-02	1.12E-02
Photochemical ozone formation (POCP)	kg NMVOC eq.	2.76E-03	2.75E-03	2.75E-03	2.75E-03	2.77E-03	2.76E-03
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	4.86E-07	4.86E-07	4.86E-07	4.86E-07	4.88E-07	4.87E-07
Abiotic depletion potential - Fossil (ADP - F)	MJ	5.35E+00	5.35E+00	5.35E+00	5.35E+00	5.38E+00	5.37E+00
Water depletion Potential (WDP)	m^3	7.04E+00	7.02E+00	7.02E+00	7.01E+00	7.16E+00	7.10E+00

Table 122 - Additional environmental impact per 1 kg Tee Connector for module C3.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	4.85E-01	4.84E-01	4.84E-01	4.84E-01	4.90E-01	4.87E-01
Particulate matter	disease incidence	1.26E-08	1.26E-08	1.26E-08	1.26E-08	1.29E-08	1.27E-08
Ionising radiation - human health	kBq U-235 eq	7.68E-04	7.68E-04	7.68E-04	7.68E-04	7.69E-04	7.69E-04
Eco-toxicity (freshwater)	CTUe	1.16E+00	1.16E+00	1.16E+00	1.16E+00	1.18E+00	1.17E+00
Human toxicity potential - cancer effects	CTUh	6.17E-11	6.16E-11	6.16E-11	6.15E-11	6.25E-11	6.21E-11
Human toxicity potential - non cancer effects	CTUh	1.12E-09	1.12E-09	1.12E-09	1.12E-09	1.13E-09	1.13E-09
Soil quality	dimensionless	5.83E-01	5.81E-01	5.81E-01	5.80E-01	5.94E-01	5.88E-01

Table 123 - Use of resources per 1 kg Tee Connector for module C3.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
PERE	MJ	2.10E-01	2.10E-01	2.09E-01	2.09E-01	2.15E-01	2.13E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.10E-01	2.10E-01	2.09E-01	2.09E-01	2.15E-01	2.13E-01
PENRE	MJ	5.38E+00	5.37E+00	5.37E+00	5.37E+00	5.40E+00	5.39E+00
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	5.38E+00	5.37E+00	5.37E+00	5.37E+00	5.40E+00	5.39E+00
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	5.68E-03	5.68E-03	5.68E-03	5.68E-03	5.69E-03	5.69E-03

Table 124 - Waste generated per 1 kg Tee Connector for module C3.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	7.21E-07	7.20E-07	7.19E-07	7.19E-07	7.29E-07	7.25E-07
Non-hazardous waste disposed	kg	3.02E-01	3.02E-01	3.02E-01	3.02E-01	3.03E-01	3.02E-01
Radioactive waste disposed	kg	2.41E-07	2.41E-07	2.41E-07	2.41E-07	2.42E-07	2.42E-07

Table 125 - Output flows generated per 1 kg Tee Connector for module C3.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	6.01E+00	8.01E+00	9.11E+00	1.31E+01	2.12E+01	3.21E+01
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.8.7. Results for module C4 (Waste disposal) [20]

Table 126 - Environmental impacts per 1 kg Tee Connector for module C4.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ozone depletion potential (ODP)	kg CFC 11 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acidification potential (AP)	mol H^+ eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eutrophication, freshwater (EP - F)	kg P eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eutrophication, marine (EP - M)	kg N eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eutrophication, terrestrial (EP - T)	mol N eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Photochemical ozone formation (POCP)	kg NMVOC eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Abiotic depletion potential - Fossil (ADP - F)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Water depletion Potential (WDP)	m^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

[20] Environmental impacts for C4 module are zero as there will be no landfilling for Scenario 1.

Table 127 - Additional environmental impact per 1 kg Tee Connector for module C4.

Indicator	Unit	Straight/Gradient/Elevated Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Particulate matter	disease incidence	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ionising radiation - human health	kBq U-235 eq	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eco-toxicity (freshwater)	CTUe	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Human toxicity potential - cancer effects	CTUh	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Human toxicity potential - non cancer effects	CTUh	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Soil quality	dimensionless	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 128 - Use of resources per 1 kg Tee Connector for module C4.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
PERE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 129 - Waste generated per 1 kg Tee Connector for module C4.

ndicator	Unit	Tee Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-hazardous waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 130 - Output flows generated per 1 kg Tee Connector for module C4.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.8.8. Results for module D (Recycling benefits beyond the system boundary)

Table 131 - Environmental impacts per 1 kg Tee Connector for module D.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	-1.61E+00	-1.61E+00	-1.61E+00	-1.60E+00	-1.61E+00	-1.61E+00
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	-8.35E-03	-8.35E-03	-8.35E-03	-8.35E-03	-8.33E-03	-8.34E-03
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	-4.92E-04	-4.92E-04	-4.92E-04	-4.91E-04	-4.95E-04	-4.94E-04
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	-1.62E+00	-1.61E+00	-1.61E+00	-1.61E+00	-1.62E+00	-1.62E+00
Ozone depletion potential (ODP)	kg CFC 11 eq.	-4.10E-08	-4.10E-08	-4.09E-08	-4.09E-08	-4.14E-08	-4.12E-08
Acidification potential (AP)	mol H^+ eq.	-5.78E-03	-5.77E-03	-5.77E-03	-5.77E-03	-5.82E-03	-5.80E-03
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	-1.20E-03	-1.19E-03	-1.19E-03	-1.19E-03	-1.22E-03	-1.21E-03
Eutrophication, freshwater (EP - F)	kg P eq.	-2.61E-04	-2.61E-04	-2.60E-04	-2.60E-04	-2.67E-04	-2.64E-04
Eutrophication, marine (EP - M)	kg N eq.	-1.04E-03	-1.04E-03	-1.04E-03	-1.04E-03	-1.05E-03	-1.04E-03
Eutrophication, terrestrial (EP - T)	mol N eq.	-1.10E-02	-1.10E-02	-1.10E-02	-1.10E-02	-1.11E-02	-1.11E-02
Photochemical ozone formation (POCP)	kg NMVOC eq.	-5.37E-03	-5.37E-03	-5.36E-03	-5.36E-03	-5.41E-03	-5.39E-03
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	-1.44E-05	-1.44E-05	-1.44E-05	-1.44E-05	-1.46E-05	-1.45E-05
Abiotic depletion potential - Fossil (ADP - F)	MJ	-5.67E+01	-5.67E+01	-5.67E+01	-5.67E+01	-5.68E+01	-5.67E+01
Water depletion Potential (WDP)	m^3	-1.29E+00	-1.29E+00	-1.29E+00	-1.29E+00	-1.29E+00	-1.29E+00

Table 132 - Additional environmental impact per 1 kg Tee Connector for module D.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	-1.50E+00	-1.49E+00	-1.49E+00	-1.49E+00	-1.50E+00	-1.50E+00
Particulate matter	disease incidence	4.83E-08	4.82E-08	4.82E-08	4.81E-08	4.90E-08	4.87E-08
Ionising radiation - human health	kBq U-235 eq	1.07E-01	1.07E-01	1.07E-01	1.07E-01	1.08E-01	1.08E-01
Eco-toxicity (freshwater)	CTUe	9.14E+00	9.10E+00	9.08E+00	9.05E+00	9.56E+00	9.35E+00
Human toxicity potential - cancer effects	CTUh	4.52E-10	4.44E-10	4.42E-10	4.36E-10	5.19E-10	4.86E-10
Human toxicity potential - non cancer effects	CTUh	1.04E-08	1.04E-08	1.04E-08	1.03E-08	1.07E-08	1.06E-08
Soil quality	dimensionless	1.86E+00	1.86E+00	1.86E+00	1.86E+00	1.89E+00	1.88E+00

Table 133 - Use of resources per 1 kg Tee Connector for module D.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
PERE	MJ	-9.54E-01	-9.53E-01	-9.52E-01	-9.52E-01	-9.62E-01	-9.58E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	-9.54E-01	-9.53E-01	-9.52E-01	-9.52E-01	-9.62E-01	-9.58E-01
PENRE	MJ	-6.08E+01	-6.08E+01	-6.08E+01	-6.08E+01	-6.09E+01	-6.09E+01
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	-6.08E+01	-6.08E+01	-6.08E+01	-6.08E+01	-6.09E+01	-6.09E+01
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	-1.01E-02	-1.01E-02	-1.01E-02	-1.01E-02	-1.01E-02	-1.01E-02

Table 134 - Waste generated per 1 kg Tee Connector for module D.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	-7.11E-06	-7.05E-06	-7.02E-06	-6.97E-06	-7.68E-06	-7.40E-06
Non-hazardous waste disposed	kg	-5.35E-02	-5.31E-02	-5.29E-02	-5.26E-02	-5.69E-02	-5.52E-02
Radioactive waste disposed	kg	-3.37E-05	-3.37E-05	-3.37E-05	-3.37E-05	-3.39E-05	-3.38E-05

Table 135 - Output flows generated per 1 kg Tee Connector for module D.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.9. Environmental performance results for Tee series – Landfilling at EoL scenario

All results except those for modules C3, C4 and D are same for the landfilling and recycling at EoL scenario.For the landfilling scenario module C3 and D will have zero impact, whereas the results for module C4 are provided below:

6.9.1. Results for module C4 (Waste Disposal)

Table 136 - Environmental impacts per 1 kg Tee Connector for module C4.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Global warming potential - Fossil (GWP-F)	kg CO_2 eq.	3.25E-02	3.25E-02	3.25E-02	3.25E-02	3.26E-02	3.25E-02
Global warming potential - Biogenic (GWP - B)	kg CO_2 eq.	1.24E-05	1.24E-05	1.24E-05	1.24E-05	1.24E-05	1.24E-05
Global warming potential - Land use and Land use change (GWP - Luluc)	kg CO_2 eq.	8.87E-07	8.87E-07	8.87E-07	8.87E-07	8.88E-07	8.87E-07
Global warming potential - Total (GWP - T)	**kg CO_2 eq.**	**3.25E-02**	**3.25E-02**	**3.25E-02**	**3.25E-02**	**3.26E-02**	**3.26E-02**
Ozone depletion potential (ODP)	kg CFC 11 eq.	2.22E-09	2.21E-09	2.21E-09	2.21E-09	2.22E-09	2.22E-09
Acidification potential (AP)	mol H^+ eq.	1.53E-04	1.53E-04	1.53E-04	1.53E-04	1.53E-04	1.53E-04
Eutrophication, freshwater (EP - F)	kg PO_4^{3-} eq.	6.15E-04	6.15E-04	6.15E-04	6.15E-04	6.15E-04	6.15E-04
Eutrophication, freshwater (EP - F)	kg P eq.	8.35E-07	8.35E-07	8.35E-07	8.35E-07	8.36E-07	8.35E-07
Eutrophication, marine (EP - M)	kg N eq.	3.09E-04	3.09E-04	3.09E-04	3.09E-04	3.09E-04	3.09E-04
Eutrophication, terrestrial (EP - T)	mol N eq.	4.96E-04	4.96E-04	4.95E-04	4.95E-04	4.96E-04	4.96E-04
Photochemical ozone formation (POCP)	kg NMVOC eq.	1.49E-04	1.49E-04	1.49E-04	1.49E-04	1.49E-04	1.49E-04
Abiotic depletion potential - minerals and metals (ADP)	kg Sb eq.	8.61E-08	8.61E-08	8.61E-08	8.61E-08	8.61E-08	8.61E-08
Abiotic depletion potential - Fossil (ADP - F)	MJ	2.10E-01	2.10E-01	2.10E-01	2.10E-01	2.11E-01	2.11E-01
Water depletion Potential (WDP)	m^3	1.86E-01	1.86E-01	1.86E-01	1.86E-01	1.86E-01	1.86E-01

Table 137 - Additional environmental impact per 1 kg Tee Connector for module C4.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
GWP-GHG	kg CO_2 eq.	2.86E-02	2.86E-02	2.86E-02	2.86E-02	2.86E-02	2.86E-02
Particulate matter	disease incidence	1.10E-09	1.10E-09	1.10E-09	1.10E-09	1.10E-09	1.10E-09
Ionising radiation - human health	kBq U-235 eq	1.65E-04	1.65E-04	1.65E-04	1.65E-04	1.65E-04	1.65E-04
Eco-toxicity (freshwater)	CTUe	2.46E-01	2.46E-01	2.46E-01	2.46E-01	2.46E-01	2.46E-01
Human toxicity potential - cancer effects	CTUh	6.24E-12	6.24E-12	6.24E-12	6.24E-12	6.25E-12	6.24E-12
Human toxicity potential - non cancer effects	CTUh	2.37E-10	2.37E-10	2.37E-10	2.37E-10	2.37E-10	2.37E-10
Soil quality	dimensionless	1.54E-01	1.54E-01	1.54E-01	1.54E-01	1.55E-01	1.54E-01

Table 138 - Use of resources per 1 kg Tee Connector for module C4.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
PERE	MJ	3.49E-03	3.49E-03	3.49E-03	3.49E-03	3.49E-03	3.49E-03
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	3.49E-03	3.49E-03	3.49E-03	3.49E-03	3.49E-03	3.49E-03
PENRE	MJ	2.22E-01	2.22E-01	2.21E-01	2.21E-01	2.22E-01	2.22E-01
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.22E-01	2.22E-01	2.21E-01	2.21E-01	2.22E-01	2.22E-01
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	5.05E-05	5.05E-05	5.05E-05	5.04E-05	5.09E-05	5.07E-05

Table 139 - Waste generated per 1 kg Tee Connector for module C4.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Hazardous waste disposed	kg	3.17E-07	3.17E-07	3.17E-07	3.17E-07	3.18E-07	3.18E-07
Non-hazardous waste disposed	kg	9.60E-01	9.59E-01	9.59E-01	9.59E-01	9.63E-01	9.61E-01
Radioactive waste disposed	kg	1.90E-07	1.90E-07	1.90E-07	1.90E-07	1.90E-07	1.90E-07

Table 140 - Output flows generated per 1 kg Tee Connector for module C4.

Indicator	Unit	Tee Series					
		090	135	150	200	300	430
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6.10. Environmental performance results for Tee series – Leaving the ducts ‘as is’ at EoL scenario

All results except those for modules C1-C4, and D are same for this scenario and recycling at EoL. Impacts for C1-C4 and D will be zero in this case.

7. Interpretation of results

- The Global Warming Potential – Total (GWPT) impacts for straight, gradient and elevated ducts range between 21.3 and 102.5 kg CO_2 eq. per meter of duct. The lowest size of these ducts, termed as 090 straight duct, has a GWPT value of 21.3 kg CO_2 eq.

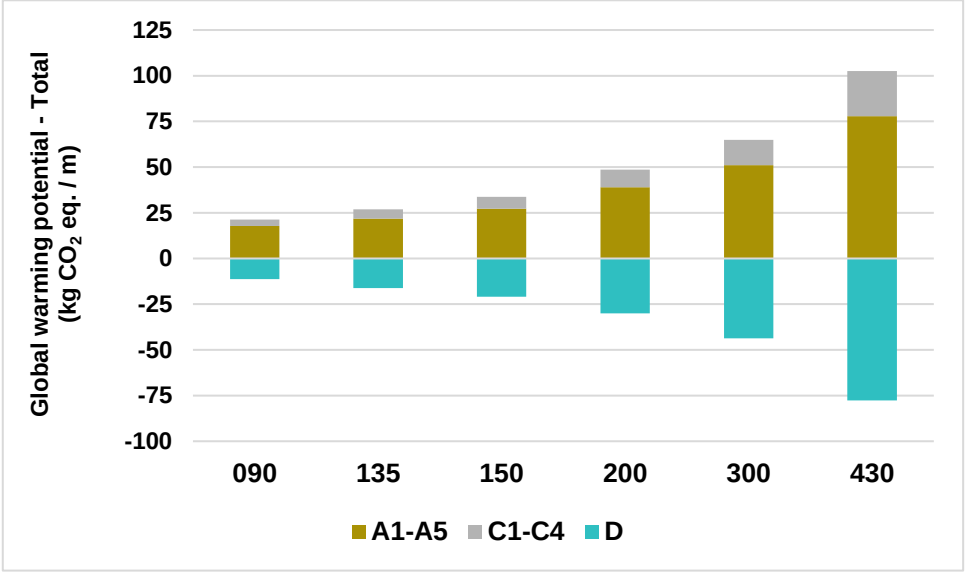


Figure 5: Global warming potential - total (GWPT) for modules A1- D for straight, elevated, and gradient duct series.

- In the case of bend series, 430 bend connectors have a GWPT value of 2.5 kg CO_2 eq. per kg of the connector and 090 bend connectors have a GWPT value of 5.6 kg CO2 eq. per kg of the connector.
- Tee series have a GWPT value range of 2.3 to 3.1 kg CO2 eq. per kg of the product. 090 tee connectors have a GWPT value of 3.1 kg CO2 eq. per kg while 430 tee connectors have a GWPT value of 2.3 kg CO2 eq. per kg.

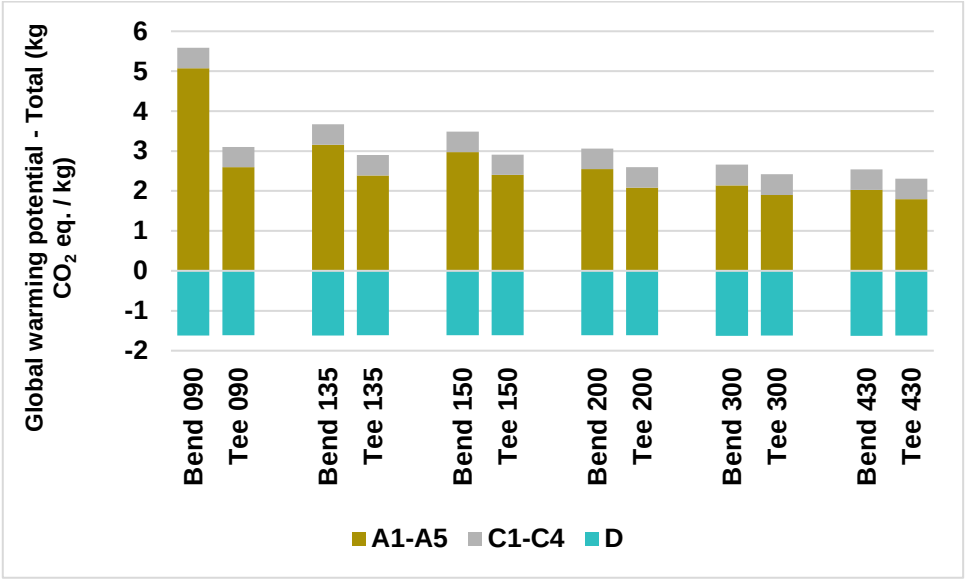


Figure 6: Global warming potential - total (GWPT) for modules A1- D for bend and tee series.

- Although the GWP (and other indicators) impact per kg exhibits a decreasing trend with respect to the size for Bend and Tee, it should be noted that impact per piece (or unit) increases with the size. For example, the GWP impact per piece of a 090 and 430 size of Bend Series is 11 kg CO2 eq and 49 kg CO_2 eq. respectively.
- The product stage is the primary contributors to all environmental impacts except water depletion potential. 70%–86% of GWP arises from the product stage. Flame retardants, recycled PE granulate and manufacturing are the primary contributors to nearly all environmental impact categories in the product stage.
- 89%–91% water depletion potential originates from waste processing.
- More than 99% of waste generated is non-hazardous in nature.
- Waste processing contributes to 9%-22% of GWPT, the second largest GWPT contributor after the product stage.

- The GWPT contribution from the installation and land disposal is less than 3% while it is less than 1% for deconstruction and waste transport.
- The resource recovery phase provides 16%–61% benefits in various environmental impact categories due to the avoided production of PE granulate and steel bolts.
- The GWP impact is 44% – 69% lower for recycling at end-of-life scenario compared to landfilling.

8. References

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Appendix A – Weight information for bend and tee joints

Table 141 - Weight information for bend and tee joints

Series	Bend (kg/piece) – including packaging	Tee (kg/piece) – including packaging
090	2.86	6.90
135	4.88	8.92
150	5.99	10.0
200	8.92	14.1
300	14.1	22.2
430	20.1	33.2

Appendix B – Guidance for calculating impacts of ducting with bend or tee joints

To calculate the impacts for a certain length of ducting with bend or tee joints, please refer to the guidance below:

1. Determine the type and length of the ducting required e.g., 1 km of Straight series 150
2. Determine number of bend or tee joints required for that length (if any), e.g., 2 x 150 series bend connectors.
3. Calculate the weight of the bend joints (refer to product description on TufDuct website or Table A in Appendx A in this case) = 2 x 5.99 kg = 12 kg
4. Calculate the required environmental impact indicator (e.g., Global Warming Potential – Total (GWP-T)) for the Straight series by multiplying the length of ducting with the relevant factor from Results table (Table 6 in this case) e.g., 1 km x (25.4 kg CO_2 eq./m) * 1000 = 25,400 kg CO_2 eq. or 25. 4 t CO_2 eq.
5. Calculate the required environmental impact indicator for the bend connectors by multiplying the total weight of connectors with the relevant factor from Results table (Table 51 in this case) = 12 kg x 2.81 kg CO_2 eq./ kg = 33.7 kg CO_2 eq.
6. GWP-T impact for 1 km of Straight Duct 150 series with 2 bend connectors = 25,400 + 33.7 = 25,434 kg CO_2 eq. or 25.4 t CO_2 eq.

Appendix C – Additional information on release of dangerous substances to indoor air, soil and water

The plastic products are highly inert and are used predominantly in outdoor applications. They do not release any dangerous substances to indoor air, soil, or water.

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