

EPD – ENVIRONMENTAL PRODUCT DECLARATION

as per ISO 14025 and EN 15804+A2



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TRM PILING SYSTEMS

Tiroler Rohre GmbH



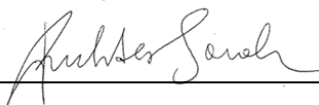
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1 General information

Product name TRM piling systems	Declared product / declared unit 1 m ductile pile with the nominal dimensions:																				
Declaration number Bau EPD-TRM- 2022-1-ECOINVENT-Pfahlsysteme	Table 1: Nominal dimensions <table border="1"> <thead> <tr> <th>Nominal outside diameter [mm]</th> <th>Nominal wall thickness [mm]</th> </tr> </thead> <tbody> <tr><td>98</td><td>6.0</td></tr> <tr><td>98</td><td>7.5</td></tr> <tr><td>118</td><td>7.5</td></tr> <tr><td>118</td><td>9.0</td></tr> <tr><td>118</td><td>10.6</td></tr> <tr><td>170</td><td>7.5</td></tr> <tr><td>170</td><td>9.0</td></tr> <tr><td>170</td><td>10.6</td></tr> <tr><td>170</td><td>13.0</td></tr> </tbody> </table>	Nominal outside diameter [mm]	Nominal wall thickness [mm]	98	6.0	98	7.5	118	7.5	118	9.0	118	10.6	170	7.5	170	9.0	170	10.6	170	13.0
Nominal outside diameter [mm]	Nominal wall thickness [mm]																				
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170	9.0																				
170	10.6																				
170	13.0																				
Declaration data <input checked="" type="checkbox"/> Specific data <input type="checkbox"/> Average data																					
Declaration based on: MS-HB version 3.0.0 from 27.06.2022 Name of the PCR: Construction products made of cast iron PCR code: 2.16.8, version: 9.0 as of 27.11.2021 (PCR tested and approved by the independent expert committee) The owner of the declaration is liable for the underlying information and evidence; Bau EPD GmbH is not liable with respect to manufacturer information, life cycle assessment data and evidence.	Number of data sets in this EPD document: 9 Range of validity The EPD applies to ductile piles of the Hall in Tyrol plant of the company Tiroler Rohre GmbH with the aforementioned nominal dimensions.																				
Type of declaration as per OENORM EN 15804+A2 From cradle to grave Energy mix approach: Market-based approach	Database, software, version Database ecoinvent 3.8, software SimaPro, version 9.3.0.3 LCA method: System model cut-off by classification																				
Author of the life cycle assessment DI Dr. Florian Gschösser floGeco Hinteranger 61d 6161 Natters Austria	The European standard EN 15804 serves as the core PCR. Independent verification of the declaration according to EN ISO 14025:2010 <input type="checkbox"/> internally <input checked="" type="checkbox"/> externally Verifier 1: DI Therese Daxner, M.Sc., Daxner & Merl GmbH Verifier 2: DI Roman Smutny, independent verifier																				
Owner of the declaration Tiroler Rohre GmbH Innsbruckerstraße 51 6060 Hall in Tyrol Austria	Publisher and programme operator Bau EPD GmbH Seidengasse 13/3 1070 Vienna Austria																				



DI (FH) DI Sarah Richter
 Head of the conformity assessment body



DI Therese Daxner, M.Sc.
 Daxner & Merl GmbH



DI Roman Smutny
 Independent verifier

Information: EPDs from similar product groups from different programmes might not be comparable.

2 Product

2.1 General product description

TRM piling systems are centrifugally ductile pile tubes (ductile cast iron) with a spigot end and a plug-in socket that can be joined to form any desired pile length. The spigot end and the plug-in socket enable the safe and easy connection of the piling elements to a ductile pile. Driven into the ground, the pile tubes form a rigid connection, absorbing centric forces and bending moments. The ductile driven pile of the TRM piling system is usually composed of one or more pile tubes (depending on the required length), a pile shoe (ungROUTED/grouted) and a self-centring pile cap. This EPD deals exclusively with the pile tubes themselves, without taking into account pile shoe types, pile caps, concrete filling and grouting.

Generally, pile tubes are produced with a length of 5 m, an outside diameter of 98 mm, 118 mm or 170 mm and a defined wall thickness.

- Type 98: Nominal outside diameter = 98 mm, nominal wall thickness = 6.0 mm or 7.5 mm
- Type 118: Nominal outside diameter = 118 mm, nominal wall thickness = 7.5 mm or 9.0 mm or 10.6 mm
- Type 170: Nominal outside diameter = 170 mm, nominal wall thickness = 7.5 mm or 9.0 mm or 10.6 mm or 13.0 mm

This environmental product declaration is a manufacturer declaration of type 1a according to MS-HB of Bau EPD GmbH from 2022, i.e. a declaration of specific products from a plant of the manufacturer.

In this environmental product declaration, electricity generation is modelled according to the electricity mix supplied by Tiroler Wasserkraft AG (TIWAG) to Tiroler Rohre GmbH.

2.2 Application

The TRM piling system is applied as a full displacement pile system for the erection of buildings or engineering structures (such as bridges, wind power and photovoltaic plants, sound protection walls, pipelines, masts) and to secure excavation pits and stabilise slopes.

The TRM pile is driven into the ground, and thus effectively transmits the forces from the building into the ground. The TRM pile can also be filled with concrete or applied with or without grouting. This EPD focuses on the insertion of the pile tubes into the ground without considering any concrete filling or grouting

2.3 Product-related standards, regulations and guidelines

Table 2: Product-related regulations

Regulation	Title
OENORM B 2567:2018	Piles of ductile iron - Requirements for components, their design and installation
ETA 07/0169	European Technical Assessment - TRM-Ductile piling - ductile iron pile tubes
APPROVAL NO.: 2020-0.094.414, BMK	Approval by Federal Ministry for Climate Action, the Environment, Energy, Mobility, Innovation and Technology – TRM PILING SYSTEMS
General building inspectorate approval/General design approval no. Z-34.25-230, DIBt	Deutsches Institut für Bautechnik (German Institute for Structural Engineering), approval body for construction products and types of construction, Structural Design Control Authority - TRM DUCTILE DRIVEN PILE

2.4 Technical data

Evidence of the mechanical material properties shall be provided by the test method according to OENORM EN 545:2011, sections 6.3 and 6.4.

Table 3: General technical data for ductile cast iron piles

Name	Value	Unit
Iron density	7150	kg/m ³
Tensile strength	≥ 450	MPa
Proportional limit, 0.2% yield strength ($R_{p0.2}$)	≥ 320	MPa
Notch impact energy	≥ 10	J
Elongation at fracture	≥ 10	%
Brinell hardness	≤ 230	HB
Pile tube length	5000	mm
Pressure resistance	≥ 900	MPa
Modulus of elasticity E	170,000 ¹⁾	MPa

¹⁾ Reference value for static calculations

Table 4: Technical data for ductile cast iron piles depending on dimensions

Type	Nominal wall thickness [mm]	Longitudinally related mass [kg/m]	Rated value of the normal load capacity N_{Sd} without concrete filling and grouting (no loss of wall thickness) [kN]
98	6.0	14.40	555
98	7.5	17.20	682
118	7.5	21.00	833
118	9.0	24.42	986
118	10.6	27.96	1144
170	7.5	33.80	1225
170	9.0	37.14	1457
170	10.6	42.54	1699
170	13.0	50.42	2052

2.5 Basic/auxiliary materials

Table 5: Basic materials in mass %

Ingredients:	Mass %
Iron ²⁾	approx. 94%
Carbon ³⁾	approx. 3.5%
Silicon ⁴⁾	approx. 2%
Ferric by-elements ⁵⁾	approx. 0.5%

2) Scrap iron

3) Foundry coke carbon. The coke in the cupola furnace serves as an energy supplier for the scrap melting on the one hand and the setting of the desired carbon content on the other

4) Silicon is added in the form of SiC briquettes and/or ferro-silicon

5) Ferric by-elements are found in the steel scrap in different minor quantities (<<1%)

2.6 Production

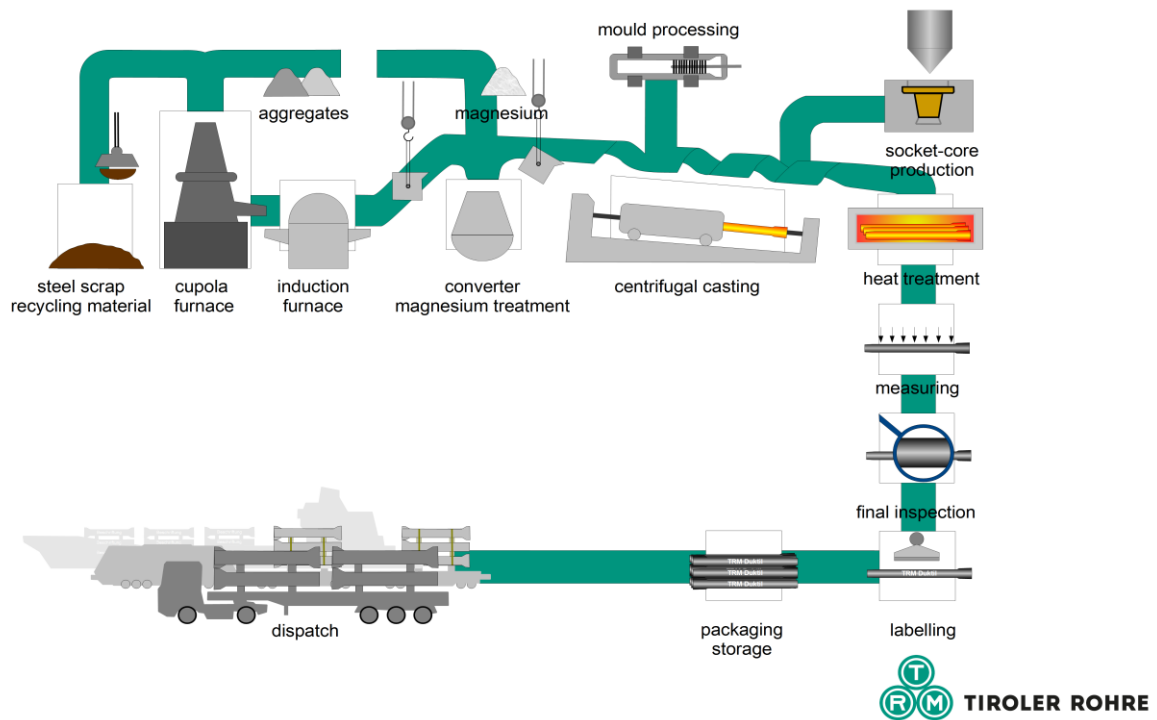


Figure 1: Flow chart of production processes

For casting production, steel scrap and recycled material are smelted in the cupola furnace with the help of coke as a reaction and reduction agent. Silicon carbide is added as an alloying element. Added aggregates enhance slagging. The chemical composition of the smelted basic iron is then constantly monitored through spectral analysis. The smelted basic iron is kept warm in the channel furnace, a storage medium, and then treated with magnesium in the Georg Fischer converter, in order to reach the appropriate ductility. The liquid iron is then cast in a centrifuge machine with the De Lavaud procedure. In order to produce a specific type of pile, this machine is equipped with the corresponding mould (metal form that the liquid iron is poured into). The socket core made of quartz sand seals the inlet of the machine and forms the plug-in socket. With the help of an automatic transport system, the glowing pile is pulled out of the cast unit and placed in a furnace. Here the product undergoes heat treatment in order to achieve the desired mechanical properties.

In the course of a final pile treatment, the pile is treated if necessary, measured, tagged and bundled. The corresponding package units are then taken to a storage area with a fork-lift.

2.7 Packaging

TRM piles are bundled with the help of squared lumber and PET binding tapes for storage and transport. Both packaging materials can be used for thermal recycling.

2.8 Delivery condition

The ductile cast iron pipes are bundled with the help of squared lumber and PET binding tapes for transport and storage. The size of the individual bundles depends on the type of pile. In the case of the type TRM 118, one bundle consists of 15 piles with dimensions of 5.5 m x 0.62 m x 0.42 m. 8 piles of the type TRM 170 form a bundle of 5.5 m x 0.72 m x 0.37 m. The TRM ductile pile needs to be transported and stored with special care. All relevant regulations for storage at the place of use and the technical provisions must be fulfilled.

2.9 Transport

Within Europe, the TRM piles are largely transported via truck to their destination and by ship for overseas destinations.

2.10 Product processing/installation

Installation and design of the full displacement piles consisting of ductile pile tubes must correspond with *Eurocode 3 - Design of steel structures (OENORM EN 1993-x/OENORM B 1993-x)*, *Eurocode 4 - Design of composite steel and concrete structures (OENORM EN 1994-x/OENORM B 1994-x)*, *Eurocode 7 - Geotechnical design (OENORM EN 1997-x/OENORM B 1997-x)* and *OENORM EN 12699: Execution of special geotechnical work – displacement piles*. National regulations must be followed accordingly.

The pile shoe forms the basis for the first pile tube. All additional pile tubes are inserted into the socket of the element previously driven into the ground, and driven into the construction ground to the final depth by displacing the soil. The excess length is then cut so that the construction ground is level with the planum and used as the starting segment for the next pile. After the driving process the pile can be filled with concrete in order to increase its inner load capacity. Pile caps on top of the piles transmit the force from the building to the piles. Optionally, piles can also have a bigger pile shoe, which forms an annular space along the entire pile circumference that can be continuously grouted with mortar during the driving process by means of a pump. This EPD focuses on the insertion of the pile tubes into the ground without consideration of any concrete filling. The installation of the pile tubes is performed with a light manoeuvrable excavator with a hydraulic blow hammer.

As the soil is displaced to the side, there is no excavated earth to deal with. Manual work is reduced to simple physical and safe procedures. All applicable safety precautions for construction sites must be observed.

2.11 Use stage

If installed and designed professionally and if the phase of utilisation is not disturbed, no modification of the material composition of construction products made of ductile cast iron occur.

2.12 Reference service life (RSL)

Table 6: Reference service life (RSL)

Name	Value	Unit
Ductile iron piles	100 ¹⁾	Years

¹⁾ Pile foundations must have a service life that corresponds with the overall construction. According to “Eurocode – Basis of structural design (OENORM EN 1990)”, engineering structures (such as bridges) have a service life of 100 years, which is why ductile cast iron piles are assessed with a corresponding service life.

2.13 Re-use and recycling

In principle, for piles made of ductile cast iron, the removal and subsequent recycling of the piles is seen as a technically and economically feasible scenario. If they do not interfere with the foundation work in the subsequent construction project (i.e. the next building), they are also partly left in the ground. For this EPD, a 100% removal rate is used as the scenario because there is a clear tendency towards the removal and recycling of the piles and because leaving valuable resources in the ground will be a very unlikely scenario in the future. However, it should be noted that the 100% removal rate is a scenario that must be examined and adjusted accordingly in the respective case.

2.14 Disposal

The piles are disposed of in very rare cases. The EAK waste code number for iron and steel from construction and demolition is 170405.

2.15 Further information

For further information about TRM piling systems and possible applications, see the website <http://trm.at/pfahl>.

3 LCA: Calculation rules

3.1 Declared unit/functional unit

The declared unit is 1 metre [m] of pile without taking into account a pile shoe, pile cap and concrete filling or grouting.

The following table is for conversion into mass [kg]

Table 7: Longitudinally related mass

Type	Longitudinally related mass [kg/m]	Mass-related length [m/kg]
98 x 6.0	14.40	0.0694
98 x 7.5	17.20	0.0581
118 x 7.5	21.00	0.0476
118 x 9.0	24.42	0.0410
118 x 10.6	27.96	0.0358
170 x 7.5	33.80	0.0296
170 x 9.0	37.14	0.0269
170 x 10.6	42.54	0.0235
170 x 13.0	50.42	0.0198

3.2 System limits

The entire product life cycle is declared. This is an EPD “From cradle to grave”.

Table 8: Declared life cycle stages

PRODUCT STAGE			CONSTRUCTION STAGE		USE STAGE							END-OF-LIFE STAGE				BENEFITS AND LOADS
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material supply	Transport	Manufacturing	Transport	Construction/Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Demolition	Transport	Waste processing	Disposal	Reuse, recovery, recycling potential
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

x = included in life cycle assessment; ND = module not declared

3.2.1 A1-A3 Production stage:

The ductile piles are almost exclusively made of the secondary material steel scrap. The system limit for the steel scrap is set when the processed steel scrap leaves the recycling plants, because the end of the waste properties of the steel scrap is reached here. This system is responsible for transporting the scrap to the TRM plant. The product stage includes the production steps in the plant along with the energy supply (including the upstream chains), the production of raw materials, auxiliary materials and packaging (including transport to the plant), the infrastructure and the disposal of the waste occurring during production.

3.2.2 A4-A5 Construction stage:

Ductile cast iron piles can be designed as unfilled or ungrouted piles or piles with concrete filling and/or grouting. This EPD focuses on the insertion of the pile tubes into the ground without considering any concrete filling. A4 includes the average transport of the piles to the construction site, A5 the driving of the piles.

The squared lumber and PET binding tapes needed for transport are thermally recycled.

3.2.3 B1-B7 Use stage:

Generally, construction products made of ductile cast iron show no impact on the LCA.

3.2.4 C1-C4 End-of-life stage:

In principle, for piles made of ductile cast iron, the removal and subsequent recycling of the piles is seen as a technically and economically feasible scenario.

The removed piles are sent for a recycling process, being considered until the end-of-waste state in the current product system is reached. The system limit is set when the processed steel scrap leaves the recycling plants. From this point on, the pile is part of a new product system.

Based on the experience of Tiroler Rohre GmbH, it is assumed that 97% of the removed piles are suitable for the recycling process and 3% have to be sent to landfill due to breakage, etc. This is the recycling scenario. The recycling scenario used is a manufacturer scenario based on the experience of Tiroler Rohre GmbH, which must be examined and adjusted accordingly in the respective case.

3.2.5 D Benefits and burdens:

Due to the recycling of the removed piles, there is a corresponding output of secondary raw materials in C3. The output flows are compared with the scrap share in the production of the cast piles in accordance with the net flow rule according to EN 15804 and the net output flow is determined and taken into account in Module D. The recycling or net flow scenario used is, as mentioned, a manufacturer scenario based on empirical values of Tiroler Rohre GmbH, which must be examined and adjusted accordingly in the respective case.

3.2.6 Multi-recycling potential:

However, due to the multi-recycling potential of the piles, they could replace primary raw materials on a gross scale in the next product system. In this EPD, the multi-recycling potential is shown as additional information. This is a value that does not comply with the rules and specifications of EN 15804. The multi-recycling potential is therefore also explicitly presented as additional information and as "non-compliant with EN 15804" in the presentation of results. As mentioned above, the consideration of the multi-recycling potential is also a manufacturer scenario based on empirical values of Tiroler Rohre GmbH. In principle, multi-recycling is only applicable if the piles are removed and do not remain in the ground.

3.3 Process flow chart during service life

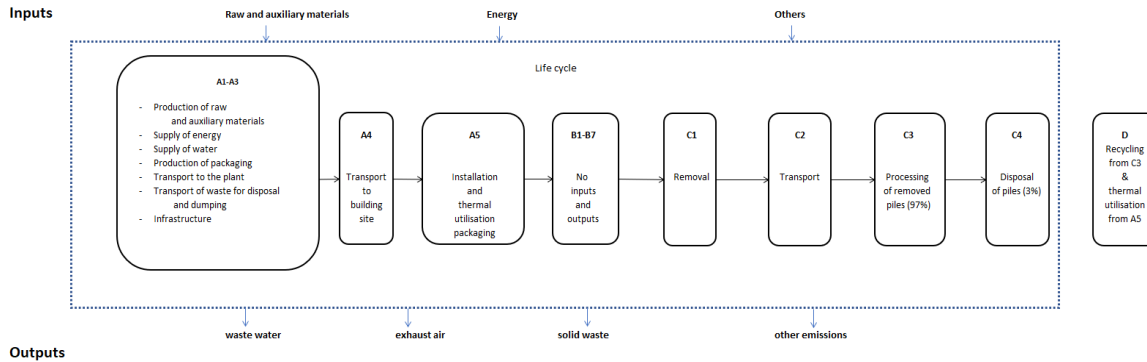


Figure 2: Service life flow chart

3.4 Estimations and assumptions

3.4.1 Silicon carbide (SiC) pellets

The SiC pellets used in casting production consist of various silicon components, Portland cement and water. In ecoinvent 3.8, there is only one data set for silicon carbide, which is typical of wafer production and has a very high SiC purity compared to the SiC component mixture used in casting production and therefore also high energy intensity (information from the manufacturer of the pellets). According to the manufacturer of the SiC pellets, the energy required to produce the SiC components or silicon carbide is reflected in the respective prices per tonne. This allows an adjustment of the SiC purity (correction factor) of the data set available in ecoinvent based on an economic comparison (i.e. in the style of an economic allocation). Quartz sand (SiO_2) was used for the mass correction of the SiC components.

3.4.2 Cast steel

Cast steel is a special steel with no data set in ecoinvent 3.8. As the cast is below 1 kg per t of casting, the ecoinvent data set for chrome steel “Steel, chromium steel 18/8, hot rolled {RER}| production | Cut-off, U” was used.

3.4.3 Magnesium

For magnesium, which mainly comes from China, the data set “Magnesium {GLO}| market for | Cut-off, U (3.8)” was used, which already includes average transport processes.

3.4.4 Infrastructure

Since the infrastructure only makes a very small contribution to environmental impact, the machinery was only shown with the main components steel and casting.

3.4.5 Use stage

For the use stage, it was assumed that no material and energy flows of relevance for the LCA occur.

3.4.1 Raw materials transports

All transport distances, with the exception of magnesium, were collected by the customer and taken into account in the LCA. For magnesium, the average transports over the data set “Magnesium {GLO}| market for | Cut-off, U (3.8)” are taken into account.

3.5 Cut-off criteria

The producer calculated and submitted the amount of all applied materials, energy needed, the packaging material, the arising waste material and the way of disposal and the necessary infrastructure (buildings and machinery for the production). The measurement values for emissions according to the casting regulations were specified.

Auxiliary materials whose material flow is less than 1% were ignored as insignificant. These are hydraulic fluid, lubricating oils, high temperature-resistant greases, additives for cooling circuits and marking ink. In-company transports were insignificant on account of the short transport distances. It can be assumed that the total number of insignificant processes is less than 5% of the impact categories.

During the production of the ductile piles, slag (from the cupola furnace) and coke dust are produced as by-products. Part of the waste heat is sold as district heating. However, these by-products contribute less than 1% to the operational income and can therefore be ignored according to the Management System Handbook of Bau EPD GmbH (MS-HB Version 3.0.0 from 27.06.2022). The system limit for the two recyclable materials slag and coke dust is set when they are collected from the plant by the future user.

3.6 Background data

As the background database, ecoinvent 3.8 with the system model cut-off by classification was applied. The software used was the programme SimaPro 9.3.0.3 from Pré.

3.7 Data quality

The data meets the following quality requirements:

The collected primary data is up-to-date (annual average over the production year 2020).

The criteria of Bau EPD GmbH for data collection, generic data and the cut-off of material and energy flows were observed.

All essential data such as energy and raw material consumption, transport distances, means of transportation and packaging within the system limits was provided by the producer.

The energy data of the production is recorded in relation to the specific area by means of counting and via the building management system. Material flows are imported into the SAP system via scales and other measuring devices. For the emissions, measured values from TÜV Süd, which are required within the framework of the casting regulations, were used. The waste quantities are taken from documents of the disposal companies.

The background database ecoinvent 3.8 was published in 2021, but contains individual data sets whose data collection or reference year is more than 10 years ago (requirement EN 15804 or Bau EPD GmbH). Over the years, these data sets have been included in the various ecoinvent database versions, taking into account necessary adjustments for database updates. Nevertheless, these data sets are subject to corresponding potential for fluctuation because (technological) developments in recent years are, to some extent, not reflected in them.

Electricity generation is modelled according to the electricity mix supplied by Tiroler Wasserkraft AG (TIWAG) to Tiroler Rohre GmbH. A total of 15,225,229 kWh of the contractually secured electricity mix was supplied to Tiroler Rohre GmbH by TIWAG in 2020. TRM GmbH procures its electricity at the medium-voltage level, with the majority of the procured electricity being transformed to the low-voltage level. However, 12.98% of the total electricity consumption in pile production is at medium-voltage level (without transformation) to operate a motor in melting operations. The remaining electricity consumption in pile production is at low-voltage level, with 5.75% of the remaining 87.02% coming from the in-house photovoltaic system.

The data is representative of the piling systems manufactured in the Hall in Tyrol plant in the 2020 production year from Table 1.

3.8 Reporting period

The data used for the production of the piles corresponds to the annual average of the production year 2020. Production and sales figures in 2020 were not affected by the COVID-19 pandemic.

3.9 Allocation

The system limit for the steel scrap is set when the processed steel scrap leaves the recycling plants because the end of the waste properties of the steel scrap is reached here. This system is responsible for transporting the scrap to the TRM plant.

In the liquid iron sector, an allocation by mass was carried out between the piles considered in this EPD and the products not considered (TRM pipe systems), based on receipt of goods. The same applies to waste.

During the production of the ductile piles, slag and coke dust are produced as by-products. Part of the waste heat is sold as district heating. However, these by-products contribute less than 1% to the operational income and can therefore be ignored according to the Management System Handbook (MS-HB Version 3.0.0 from 27.06.2022) of Bau EPD GmbH.

In the case of heat treatment, the deviations in energy expenditure and thus in the associated LCA results are very small depending on the pile types, which is why a breakdown of heat treatment by type is not provided.

The materials produced during pile manufacture - foundry debris, fly-ash, filter cake from cupola furnace dust extraction and converter slag - are taken to a recycling plant for processing. Since no detailed information is available on the further treatment processes and because the influence on the results of the impact categories is classified as negligible, the system limit is set when the substances arrive at the recycling plant.

The system limit for the steel scrap used in production is set when the processed steel scrap leaves the recycling plants, because the end of the waste properties of the steel scrap is reached here. This system is responsible for transporting the scrap to the TRM plant. The system limit for removed piles is set when the processed steel scrap leaves the recycling plants. From this point on, the processed pile is part of a new product system.

Due to the recycling of the removed piles, there is a corresponding output of secondary raw materials in C3. The output flows are compared with the scrap share in the production of the cast piles in accordance with the net flow rule according to EN 15804 and the net output flow is determined. The recycling or net flow scenario used is, as mentioned, a manufacturer scenario based on empirical values of Tiroler Rohre GmbH, which must be examined and adjusted accordingly in the respective case.

3.10 Comparability

In principle, a comparison or evaluation of EPD data is only possible if all data sets to be compared have been created in accordance with EN 15804, the same programme-specific PCR/any additional rules and the same background database have been used, and the building context/product-specific performance characteristics are also taken into account.

4 LCA: Scenarios and further technical information

4.1 A1-A3 Production stage

According to OENORM EN 15804, no technical scenario details are required for A1-A3 as the producer is responsible for the accounting of these modules, and this must not be changed by the user of the LCA.

Data collection for the production stage was carried out according to ISO 14044 Section 4.3.2. In accordance with the target definition, all relevant input and output flows that occur in connection with the product under consideration were identified and quantified in the life cycle inventory analysis.

4.2 A4-A5 Construction stage

4.2.1 Description of the scenario "Transport to the building site (A4)"

Within Europe, the piles are transported via truck to their destination and by ship for overseas destinations. The client provided the information on the transports as shown in Table 9.

Table 9: Average transport distances

Country name	Allocation	Average transport routes	
		Truck [km]	Ship [km]
Austria	41.2%	303	
Switzerland	9.3%	297	
Germany	34.0%	327	
Italy	2.8%	204	
Spain	0.7%	1 955	
France	8.3%	949	
England	0.1%	1 452	
Czech Republic	0.5%	539	
Luxembourg	0.2%	658	
USA	1.8%	3 810	6 500
South Africa	1.1%	1 635	12 700
	100.0%		

Table 10 shows the general parameters to describe the transport to the building site.

Table 10: Description of the scenario “Transport to the building site (A4)”

Parameters to describe the transport to the building site (A4)	Value	Measurement unit
Average transport distance	see Table 9	km
Vehicle type according to Commission Directive 2007/37/EC (European Emission Standard)	Euro 6 or transoceanic freight ship	-
Average fuel consumption, fuel type: Diesel or heavy oil	25.3 or 9,000	l/100 km
Average transport mass	5.79 or 43,000	t
Average capacity utilisation (including empty returns)	100 or 70	%
Average gross density of transported products	7150	kg/m ³
Volume capacity utilisation factor (factor: =1 or <1 or ≥ 1 for compressed or nested packaged products)	<1	-

4.2.2 Description of the scenario “Installation of the product in the building (A5)”

As standard, the piles are driven into the ground with a hydraulic excavator equipped with a hydraulic blow hammer. For all pile types, a hydraulic excavator with an engine power of 150 kW and a weight of 35 t (ÖBGL (Austrian Building Equipment List) no. D.1.03.0150) is used as standard equipment for the installation. Empirical values show a working capacity of 300 m of manufactured pile per day for this unit (regardless of pile type), which corresponds to 37.5 m of pile per hour. With an engine power of 150 kW for the hydraulic excavator, this results in an energy demand (diesel) of 4 kWh per m of pile or 14.4 MJ per m of pile. With a diesel requirement of 0.125 kg diesel per kWh (according to ÖBGL 80 up to 170 g/kWh), this results in a diesel requirement of 0.5 kg diesel per m of pile, or at 0.84 kg/L diesel, of 0.595 L diesel per m of pile.

The stacked wood and binding tapes (PET) used for transport are thermally recycled in a waste incinerator 100 km away.

Table 11: Description of the scenario “Installation (A5)”

Parameters to describe the installation (A5)	Value	Measurement unit
Auxiliary materials for the installation	-	kg/m
Aids for the installation	Hydraulic excavator	-
Water consumption	-	m ³ /m
Other resource use	-	kg/m
Electricity consumption	-	kWh/m
Other energy carrier: diesel	14.4	MJ/m
Material loss on the construction site before waste treatment, caused by the installation of the product	-	kg/m
Output materials due to waste treatment on the construction site, e.g. collection for recycling, for energy recovery or for disposal	Stacked wood, PET	kg/m
Direct emissions to ambient air (e.g. dust, VOC), soil and water	-	kg/m

4.3 B1-B7 Use stage

In the use stage, no material and energy flows relevant for the LCA take place for the TRM piling systems, which is why no activities were taken into account here.

4.4 C1-C4 End-of-life stage

4.4.1 Description of the scenario “Demolition (C1)”

In principle, for piles made of ductile cast iron, the removal and subsequent recycling of the piles is seen as a technically and economically feasible scenario. If the piles do not interfere with the foundation work in the subsequent construction project (i.e. the next building), they are also partly

left in the ground. For this EPD, a 100% removal rate is used as the scenario, because there is a clear tendency towards the removal and recycling of the piles and because leaving valuable resources in the ground will be a very unlikely scenario in the future. However, it should be noted that the 100% removal rate is a scenario that must be examined and adjusted accordingly in the respective case.

The removed piles are sent for a recycling process, being considered until the end-of-waste state in the current product system. The system limit is set when the processed steel scrap leaves the recycling plants. From this point on, the pile is part of a new product system. Based on the experience of Tiroler Rohre GmbH, it is assumed that 97% of the piles are suitable for the recycling process and 3% have to be sent to landfill. This is the recycling scenario. The recycling scenario used is, as mentioned, a manufacturer scenario based on empirical values of Tiroler Rohre GmbH, which must be examined and adjusted accordingly in the respective case.

The piles are removed with the same excavator that was used to install them. The working capacity (300 m of pile/d or 37.5 m of pile/h) and the diesel requirement (14.4 MJ/m of pile) are assumed to be identical as for the installation of the piles and are also modelled with the same data sets.

Table 12: Description of the scenario “Demolition (C1)”

Parameters to describe the demolition (C1)	Value	Measurement unit
Auxiliary materials for the demolition	-	kg/m
Aids for the demolition	Hydraulic excavator	-
Water consumption	-	m ³ /m
Other resource use	-	kg/m
Electricity consumption	-	kWh/m
Other energy carrier: diesel	14.4	MJ/m
Material loss on the construction site before waste treatment, caused by the installation of the product	-	kg/m
Output materials due to waste treatment on the construction site, e.g. collection for recycling, for energy recovery or for disposal	-	kg/m
Direct emissions to ambient air (e.g. dust, VOC), soil and water	-	kg/m

4.4.2 Description of the scenario “Transport processes (C2)”

The transport distance to the nearest recycling company (97% of the piles) as well as to the nearest inert material landfill (3% of the piles) was assumed to be 100 km. A utilisation of 100% is assumed as the scenario for the transports because a maximum utilisation must be regarded as the target for effective transports.

Table 13: Description of the scenario “Transport for disposal (C2)”

Parameters to describe the transport for disposal (C2)	Value	Measurement unit
Average transport distance	100	km
Vehicle type according to Commission Directive 2007/37/EC (European Emission Standard)	Euro 6	-
Average fuel consumption, fuel type: Diesel or heavy oil	25.3	l/100 km
Average transport mass	5.79	t
Average capacity utilisation (including empty returns)	100	%
Average gross density of transported products	7150	kg/m ³
Volume capacity utilisation factor (factor: =1 or <1 or ≥ 1 for compressed or nested packaged products)	<1	-

4.4.3 Description of the scenario “Waste processing (C3)”

In C3, the recycling of the piles (97%), i.e. the processing of the removed piles in a recycling plant into a secondary raw material that can be used in cast iron and steel production, is taken into account. For this purpose, it is assumed that the pile is sent as a whole to the recycling plant, where any materials that cannot be used for cast iron and steel production (these are usually small amounts of soil and rock material) are separated out. The treatment of these separated out materials is cut off due to the expected low quantities (and therefore minor influence on the results). A new product system begins with the transport of the processed scrap from the recycling plant to the production plant.

4.4.4 Description of the scenario “Disposal (C4)”

In C4, the disposal of 3% of the pile mass in an inert material landfill is considered.

Table 14: Disposal processes (C3 and C4) per m of pile

Pile type	Mass per metre of pile	Total pile mass for recycling 97%	Total pile mass for disposal 3%
	[kg/m]	[kg/m]	[kg/m]
98/6	14.4	13.97	0.43
98/7.5	17.2	16.68	0.52
118/7.5	21	20.37	0.63
118/9	24.42	23.69	0.73
118/10.6	27.96	27.12	0.84
170/7.5	33.8	32.79	1.01
170/9	37.14	36.03	1.11
170/10.6	42.54	41.26	1.28
170/13	50.42	48.91	1.51

Table 15: Description of the scenario “Disposal of the product (C1 to C4)”

Parameters for end-of-life stage (C1-C4)	Value	Measurement unit
Collection process, separate	see Table 14, column 2	kg collected separately
Recycling	see Table 14, column 3	kg recycling
Disposal, inert material landfill	see Table 14, column 4	kg product or material for final deposition

4.5 D Reuse, recovery, recycling potential

4.5.1 Description of the scenario “Benefits and burdens (D)”

Due to the recycling of the removed piles (97%), there is a corresponding output of secondary raw materials in C3. Due to the net flow rule according to EN 15804 and the high proportion of scrap in the production of cast piles (988 kg per tonne of pile), there is a slightly negative net output flow here (Table 16).

Table 16: Net flow of steel scrap in C3

Pile type	Mass per metre of pile	Total pile mass for recycling 97%	Scrap input per metre of pile	D from C3 Net flow
	[kg/m]	[kg/m]	[kg/m]	[kg/m]
98/6	14.4	13.97	14.227	-0.259
98/7.5	17.2	16.68	16.994	-0.310
118/7.5	21	20.37	20.748	-0.378
118/9	24.42	23.69	24.127	-0.440
118/10.6	27.96	27.12	27.624	-0.503
170/7.5	33.8	32.79	33.394	-0.608
170/9	37.14	36.03	36.694	-0.669
170/10.6	42.54	41.26	42.030	-0.766
170/13	50.42	48.91	49.815	-0.908

For the calculation of D from A5, the lower heating values are taken from the ecoinvent data sets for thermal utilisation (“Waste wood, untreated {CH} treatment of, municipal incineration | Cut-off, U (3.8)” – 13.99 MJ/kg or “Waste polyethylene terephthalate {CH} treatment of waste polyethylene terephthalate, municipal incineration | Cut-off, U” – 22.95 MJ/kg). For thermal utilisation, it was assumed that the energy recovery is divided into 1/3 electricity (with efficiency of 17%) and 2/3 heat (with efficiency of 75%) (Table 17).

Table 17: D from A5

Pile type 98/6	Output	Heating value, lower	Electricity benefit	Heat benefit
	[kg/m]	[MJ/kg]	[MJ/m]	[MJ/m]
Waste incineration (stacked wood)	5.66E-03	13.99	4.49E-03	3.96E-02
Waste incineration (PET)	2.02E-04	22.95	2.62E-04	2.31E-03
D from A5			4.75E-03	4.19E-02
Pile type 98/7.5	Output	Heating value, lower	Electricity benefit	Heat benefit
	[kg/m]	[MJ/kg]	[MJ/m]	[MJ/m]
Waste incineration (stacked wood)	6.76E-03	13.99	5.36E-03	4.73E-02
Waste incineration (PET)	2.41E-04	22.95	3.13E-04	2.76E-03
D from A5			5.67E-03	5.01E-02
Pile type 118/7.5	Output	Heating value, lower	Electricity benefit	Heat benefit
	[kg/m]	[MJ/kg]	[MJ/m]	[MJ/m]
Waste incineration (stacked wood)	8.26E-03	13.99	6.54E-03	5.77E-02
Waste incineration (PET)	2.94E-04	22.95	3.82E-04	3.37E-03
D from A5			6.93E-03	6.11E-02
Pile type 118/9	Output	Heating value, lower	Electricity benefit	Heat benefit
	[kg/m]	[MJ/kg]	[MJ/m]	[MJ/m]
Waste incineration (stacked wood)	9.60E-03	13.99	7.61E-03	6.72E-02
Waste incineration (PET)	3.42E-04	22.95	4.45E-04	3.92E-03
D from A5			8.06E-03	7.11E-02
Pile type 118/10.6	Output	Heating value, lower	Electricity benefit	Heat benefit
	[kg/m]	[MJ/kg]	[MJ/m]	[MJ/m]
Waste incineration (stacked wood)	1.10E-02	13.99	8.71E-03	7.69E-02
Waste incineration (PET)	3.91E-04	22.95	5.09E-04	4.49E-03
D from A5			9.22E-03	8.14E-02
Pile type 170/7.5	Output	Heating value, lower	Electricity benefit	Heat benefit
	[kg/m]	[MJ/kg]	[MJ/m]	[MJ/m]
Waste incineration (stacked wood)	1.33E-02	13.99	1.05E-02	9.29E-02
Waste incineration (PET)	4.73E-04	22.95	6.15E-04	5.43E-03
D from A5			1.11E-02	9.84E-02
Pile type 170/9	Output	Heating value, lower	Electricity benefit	Heat benefit
	[kg/m]	[MJ/kg]	[MJ/m]	[MJ/m]
Waste incineration (stacked wood)	1.46E-02	13.99	1.16E-02	1.02E-01
Waste incineration (PET)	5.20E-04	22.95	6.76E-04	5.97E-03
D from A5			1.23E-02	1.08E-01
Pile type 170/10.6	Output	Heating value, lower	Electricity benefit	Heat benefit
	[kg/m]	[MJ/kg]	[MJ/m]	[MJ/m]
Waste incineration (stacked wood)	1.67E-02	13.99	1.33E-02	1.17E-01
Waste incineration (PET)	1.73E-03	22.95	2.25E-03	1.99E-02
D from A5			1.55E-02	1.37E-01

Pile type 170/13	Output	Heating value, lower	Electricity benefit	Heat benefit
	[kg/m]	[MJ/kg]	[MJ/m]	[MJ/m]
Waste incineration (stacked wood)	1.98E-02	13.99	1.57E-02	1.39E-01
Waste incineration (PET)	7.06E-04	22.95	9.18E-04	8.10E-03
D from A5			1.66E-02	1.47E-01

Table 18: Description of the scenario “Reuse, recovery, recycling potential (Module D)”

Parameters for the module (D)	Value	Measurement unit
Materials for reuse or recycling from A4-A5	-	%
Energy recovery or secondary fuels from A4-A5	See Table 17, Column 2 (= Secondary fuels), Column 4 (= Electricity energy recovery), Column 6 (= Heat energy recovery)	kg/m
Materials for reuse or recycling from B2-B5	-	%
Energy recovery or secondary fuels from B2-B5	-	kg/m
Materials for reuse or recycling from C1-C4	97	%
Energy recovery or secondary fuels from C1-C4	-	kg/m

4.5.2 Description of the scenario for additional information “Multi-recycling potential”

Due to the multi-recycling potential of the piles, they could replace primary raw materials (pig iron) on a gross scale in the next product system. In this EPD, the multi-recycling potential is shown as additional information. This is a value that does not comply with the rules and specifications of EN 15804. The multi-recycling potential is therefore also explicitly presented as additional information and as “non-compliant with EN 15804” in the presentation of results. As mentioned above, the consideration of the multi-recycling potential is also a manufacturer scenario based on empirical values of Tiroler Rohre GmbH. In principle, multi-recycling is only applicable if the piles are removed and do not remain in the ground.

5 LCA: Results

5.1 98/6 mm TRM piling system

Table 19: Results of parameters describing the environmental impact per metre [m] of 98/6 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
GWP total	kg CO2 equiv	13.97	1.10	1.48	0.00	1.47	0.23	0.34	2.27E-03	-2.14E-03	0.44		-23.54
GWP fossil	kg CO2 equiv	13.89	1.10	1.47	0.00	1.47	0.23	0.35	2.26E-03	-2.13E-03	0.44		-23.60
GWP biogenic	kg CO2 equiv	7.45E-02	9.16E-04	9.47E-03	0.00E+00	1.21E-03	2.03E-04	-6.14E-03	2.24E-06	-5.26E-06	-1.37E-03		7.40E-02
GWP luluc	kg CO2 equiv	4.18E-03	4.51E-04	2.54E-04	0.00E+00	2.54E-04	9.38E-05	6.66E-04	2.14E-06	-1.83E-06	1.24E-04		-6.68E-03
ODP	kg CFC-11 equiv	7.21E-07	2.54E-07	2.93E-07	0.00E+00	0.00	5.43E-08	4.63E-08	9.16E-10	-1.46E-10	1.75E-08		-9.42E-07
AP	mol H+ equiv	3.37E-02	4.16E-03	1.43E-02	0.00E+00	0.01	6.66E-04	4.15E-03	2.13E-05	-6.58E-06	1.59E-03		-8.56E-02
EP freshwater	kg P equiv	5.11E-03	7.09E-05	1.06E-04	0.00E+00	0.00	1.54E-05	2.21E-04	2.07E-07	-4.55E-07	1.73E-04		-9.32E-03
EP saltwater	kg N equiv	8.60E-03	8.93E-04	6.22E-03	0.00E+00	0.01	1.35E-04	9.41E-04	7.40E-06	-1.32E-06	3.77E-04		-2.03E-02
EP land	mol N equiv	8.77E-02	9.79E-03	6.80E-02	0.00E+00	0.07	1.48E-03	1.05E-02	8.11E-05	-1.35E-05	4.00E-03		-2.16E-01
POCP	kg NMVOC equiv	2.78E-02	3.38E-03	1.89E-02	0.00E+00	0.02	5.67E-04	2.91E-03	2.36E-05	-4.01E-06	2.20E-03		-1.19E-01
ADP minerals and metals	kg Sb equiv	2.54E-05	3.82E-06	1.49E-06	0.00E+00	0.00	8.31E-07	4.14E-05	5.17E-09	-1.78E-09	3.30E-07		-1.78E-05
ADP fossil fuels	MJ Hu	162.99	16.59	20.04	0.00	20.04	3.56	4.82	0.06	-0.03	4.43	-238.70	
WDP	m3 world equiv deprived	3.42	0.05	0.07	0.00	0.07	0.01	0.06	0.00	0.00	0.02	-1.25	
Legend	GWP = Global warming potential; luluc = Land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP = Abiotic depletion potential; WDP = Water deprivation potential (users)												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 20: Results of additional environmental impact indicators per metre [m] of 98/6 mm piling system

Compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PM	Disease incidence	1.82E-06	8.69E-08	3.77E-07	0.00E+00	3.77E-07	1.89E-08	5.58E-08	4.29E-10	-4.33E-11	2.93E-08		-1.58E-06
IRP	kBq U235 equiv	6.15E-01	8.52E-02	9.84E-02	0.00E+00	9.84E-02	1.83E-02	4.94E-02	2.81E-04	-1.41E-04	7.83E-03		-4.22E-01
ETP-fw	CTUe	223.33	12.95	13.78	0.00	13.78	2.79	17.68	0.04	-0.02	13.10		-706.48
HTP-c	CTUh	1.41E-08	4.29E-10	1.13E-09	0.00E+00	1.13E-09	8.97E-11	5.96E-10	1.01E-12	-3.76E-13	2.34E-09		-1.26E-07
HTP-nc	CTUh	1.23E-07	1.30E-08	1.07E-08	0.00E+00	1.07E-08	2.82E-09	2.61E-08	2.63E-11	-1.05E-11	9.00E-09		-4.85E-07
SQP	Points	34.07	11.31	2.71	0.00	2.71	2.48	8.90	0.13	-2.75E-03	0.86	-46.61	
Legend	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems - freshwater; HTP-c = Potential toxicity comparison unit for humans - carcinogenic effect; HTP-nc = Potential toxicity comparison unit for humans - non-carcinogenic effect; SQP = Potential soil quality index												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 21: Results of parameters describing resource use per metre [m] of 98/6 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 _{SEP} A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PERE	MJ H _u	18.99	0.23	0.33	0.00	0.25	0.05	0.75	5.40E-04	-1.43E-03	0.09		-4.91
PERM	MJ H _u	0.08	0.00	-0.08	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PERT	MJ H _u	19.07	0.23	0.25	0.00	0.25	0.05	0.75	5.40E-04	-1.43E-03	0.09		-4.91
PENRE	MJ H _u	162.99	16.59	20.05	0.00	20.04	3.56	4.82	6.33E-02	-3.13E-02	4.43		-238.71
PENRM	MJ H _u	4;63E-03	0.00	-4.63E-03	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PENRT	MJ H _u	162.99	16.59	20.05	0.00	20.04	3.56	4.82	6.33E-02	-3.13E-02	4.43		-238.71
SM	kg	14.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.26		0.00
RSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
NRSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
FW	m ³	1.34E-01	1.82E-03	2.33E-03	0.00E+00	2.33E-03	3.95E-04	2.45E-03	6.72E-05	-9.06E-06	7.54E-04	-4.07E-02	
Legend	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy resources as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of fresh water												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 22: Results of waste categories and output flows per metre [m] of 98/6 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
HWD	kg	1.90E-04	4.26E-05	5.75E-05	0.00E+00	5.75E-05	9.28E-06	1.39E-05	9.56E-08	-2.36E-08	4.73E-05		-2.55E-03
NHWD	kg	1.19	0.85	0.06	0.00	0.06	0.19	0.15	0.43	0.00	0.01		-0.78
RWD	kg	5.74E-04	2.24E-04	2.61E-04	0.00E+00	2.61E-04	4.79E-05	5.51E-05	8.27E-07	-7.38E-08	9.13E-06		-4.93E-04
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
MFR	kg	0.00	0.00	0.00	0.00	0.00	0.00	13.97	0.00	0.00	0.00		0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
EEE	MJ	0.00E+00	0.00E+00	6.93E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
EET	MJ	0.00E+00	0.00E+00	6.11E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
Legend	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electric energy; EET = Exported thermal energy												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 23: Results of description of biogenic carbon content at the gate per metre [m] of 98/6 mm piling system

Results compliant with EN 15804											
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3
C content product	kg C	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C content packaging	kg C	2.62E-03	0.00E+00	-2.62E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Legend	C content product = biogenic carbon content in the product; C content packaging = biogenic carbon content in the associated packaging										

C content beech wood = 46.3%, beech wood packaging = 5.66E-03 kg/m

5.2 98/7.5 mm TRM piling system

Table 24: Results of parameters describing the environmental impact per metre [m] of 98/7.5 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
GWP total	kg CO2 equiv	16.69	1.32	1.48	0.00	1.47	0.28	0.41	2.74E-03	-2,55E-03	0.52		-28.10
GWP fossil	kg CO2 equiv	16.59	1.31	1.47	0.00	1.47	0.28	0.42	2.74E-03	-2.54E-03	0.52		-28.18
GWP biogenic	kg CO2 equiv	8.90E-02	1.09E-03	1.11E-02	0.00E+00	1.21E-03	2.42E-04	-7.33E-03	2.71E-06	-6.28E-06	-1.64E-03		8.83E-02
GWP luluc	kg CO2 equiv	4.99E-03	5.39E-04	2.54E-04	0.00E+00	2.54E-04	1.12E-04	7.95E-04	2.59E-06	-2.18E-06	1.48E-04		-7.98E-03
ODP	kg CFC-11 equiv	8.61E-07	3.03E-07	2.93E-07	0.00E+00	0.00	6.49E-08	5.53E-08	1.11E-09	-1.75E-10	2.09E-08		-1.13E-06
AP	mol H+ equiv	4.03E-02	4.97E-03	1.43E-02	0.00E+00	0.01	7.96E-04	4.96E-03	2.58E-05	-7.86E-06	1.90E-03		-1.02E-01
EP freshwater	kg P equiv	6.11E-03	8.47E-05	1.06E-04	0.00E+00	0.00	1.84E-05	2.64E-04	2.51E-07	-5.43E-07	2.07E-04		-1.11E-02
EP saltwater	kg N equiv	1.03E-02	1.07E-03	6.22E-03	0.00E+00	0.01	1.62E-04	1.12E-03	8.95E-06	-1.57E-06	4.51E-04		-2.43E-02
EP land	mol N equiv	1.05E-01	1.17E-02	6.80E-02	0.00E+00	0.07	1.76E-03	1.26E-02	9.80E-05	-1.62E-05	4.78E-03		-2.57E-01
POCP	kg NMVOC equiv	3.32E-02	4.03E-03	1.89E-02	0.00E+00	0.02	6.77E-04	3.48E-03	2.85E-05	-4.79E-06	2.63E-03		-1.42E-01
ADP minerals and metals	kg Sb equiv	3.03E-05	4.57E-06	1.49E-06	0.00E+00	0.00	9.93E-07	4.94E-05	6.25E-09	-2.12E-09	3.95E-07		-2.12E-05
ADP fossil fuels	MJ Hu	194.69	19.81	20.05	0.00	20.04	4.25	5.75	0.08	-0.04	5.30	-285.00	
WDP	m3 world equiv deprived	4.08	0.06	0.07	0.00	0.07	0.01	0.08	0.00	0.00	0.03	-1.50	
Legend	GWP = Global warming potential; luluc = Land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP = Abiotic depletion potential; WDP = Water deprivation potential (users)												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 25: Results of additional environmental impact indicators per metre [m] of 98/7.5 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PM	Disease incidence	2.18E-06	1.04E-07	3.77E-07	0.00E+00	3.77E-07	2.26E-08	6.66E-08	5.19E-10	-5.17E-11	3.50E-08		-1.89E-06
IRP	kBq U235 equiv	7.34E-01	1.02E-01	9.84E-02	0.00E+00	9.84E-02	2.19E-02	5.90E-02	3.40E-04	-1.68E-04	9.37E-03		-5.04E-01
ETP-fw	CTUe	266.76	15.46	13.78	0.00	13.78	3.33	21.11	0.05	-0.03	15.68		-843.53
HTP-c	CTUh	1.69E-08	5.12E-10	1.13E-09	0.00E+00	1.13E-09	1.07E-10	7.12E-10	1.23E-12	-4.50E-13	2.80E-09		-1.51E-07
HTP-nc	CTUh	1.47E-07	1.55E-08	1.07E-08	0.00E+00	1.07E-08	3.37E-09	3.12E-08	3.18E-11	-1.26E-11	1.08E-08		-5.79E-07
SQP	Points	40.69	13.51	2.71	0.00	2.71	2.96	10.62	0.16	-3.28E-03	1.03		-55.66
Legend	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems - freshwater; HTP-c = Potential toxicity comparison unit for humans - carcinogenic effect; HTP-nc = Potential toxicity comparison unit for humans - non-carcinogenic effect; SQP = Potential soil quality index												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 26: Results of parameters describing resource use per metre [m] of 98/7.5 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PERE	MJ H _u	22.68	0.28	0.34	0.00	0.25	0.06	0.89	6.53E-04	-1.70E-03	0.11		-5.87
PERM	MJ H _u	0.09	0.00	-0.09	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PERT	MJ H _u	22.78	0.28	0.25	0.00	0.25	0.06	0.89	6.53E-04	-1.70E-03	0.11		-5.87
PENRE	MJ H _u	194.68	19.82	20.05	0.00	20.04	4.25	5.76	7.65E-02	-3.74E-02	5.30		-285.01
PENRM	MJ H _u	5.53E-03	0.00	-5.53E-03	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PENRT	MJ H _u	194.68	19.82	20.05	0.00	20.04	4.25	5.76	7.65E-02	-3.74E-02	5.30		-285.01
SM	kg	16.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.31		0.00
RSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
NRSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
FW	m ³	1.60E-01	2.17E-03	2.33E-03	0.00E+00	2.33E-03	4.72E-04	2.93E-03	8.12E-05	-1.08E-05	9.03E-04		-4.86E-02
Legend	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy resources as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of fresh water												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 27: Results of waste categories and output flows per metre [m] of 98/7.5 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
HWD	kg	2.27E-04	5.08E-05	5.75E-05	0.00E+00	5.75E-05	1.11E-05	1.66E-05	1.16E-07	-2.83E-08	5.66E-05		-3.04E-03
NHWD	kg	1.42	1.01	0.06	0.00	0.06	0.22	0.18	0.52	0.00	0.02		-0.94
RWD	kg	6.86E-04	2.67E-04	2.61E-04	0.00E+00	2.61E-04	5.72E-05	6.58E-05	1.00E-06	-8.81E-08	1.09E-05		-5.88E-04
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
MFR	kg	0.00	0.00	0.00	0.00	0.00	0.00	16.68	0.00	0.00	0.00		0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
EEE	MJ	0.00E+00	0.00E+00	6.93E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
EET	MJ	0.00E+00	0.00E+00	6.11E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
Legend	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electric energy; EET = Exported thermal energy												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 28: Results of description of biogenic carbon content at the gate per metre [m] of 98/7.5 mm piling system

Results compliant with EN 15804											
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3
C content product	kg C	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C content packaging	kg C	3.13E-03	0.00E+00	-3, 13E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Legend	C content product = biogenic carbon content in the product; C content packaging = biogenic carbon content in the associated packaging										

C content beech wood = 46.3%, beech wood packaging = 6.76E-03 kg/m

5.3 118/7.5 mm TRM piling system

Table 29: Results of parameters describing the environmental impact per metre [m] of 118/7.5 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
GWP total	kg CO2 equiv	20.38	1.60	1.48	0.00	1.47	0.34	0.50	3.32E-03	-3.11E-03	0.64		-34.32
GWP fossil	kg CO2 equiv	20.26	1.60	1.47	0.00	1.47	0.34	0.51	3.32E-03	-3.10E-03	0.64		-34.42
GWP biogenic	kg CO2 equiv	1.09E-01	1.33E-03	1.33E-02	0.00E+00	1.21E-03	2.95E-04	-8.95E-03	3.29E-06	-7.67E-06	-2.00E-03		1.08E-01
GWP luluc	kg CO2 equiv	6.09E-03	6.58E-04	2.54E-04	0.00E+00	2.54E-04	1.37E-04	9.70E-04	3.13E-06	-2.66E-06	1.81E-04		-9.74E-03
ODP	kg CFC-11 equiv	1.05E-06	3.70E-07	2.93E-07	0.00E+00	0.00	7.92E-08	6.76E-08	1.34E-09	-2.13E-10	2.55E-08		-1.37E-06
AP	mol H+ equiv	4.92E-02	6.06E-03	1.43E-02	0.00E+00	0.01	9.72E-04	6.06E-03	3.12E-05	-9.61E-06	2.32E-03		-1.25E-01
EP freshwater	kg P equiv	7.45E-03	1.03E-04	1.06E-04	0.00E+00	0.00	2.24E-05	3.23E-04	3.04E-07	-6.64E-07	2.52E-04		-1.36E-02
EP saltwater	kg N equiv	1.25E-02	1.30E-03	6.22E-03	0.00E+00	0.01	1.97E-04	1.37E-03	1.08E-05	-1.92E-06	5.50E-04		-2.96E-02
EP land	mol N equiv	1.28E-01	1.43E-02	6.80E-02	0.00E+00	0.07	2.15E-03	1.54E-02	1.19E-04	-1.97E-05	5.83E-03		-3.14E-01
POCP	kg NMVOC equiv	4.06E-02	4.92E-03	1.89E-02	0.00E+00	0.02	8.27E-04	4.24E-03	3.45E-05	-5.85E-06	3.21E-03		-1.73E-01
ADP minerals and metals	kg Sb equiv	3.70E-05	5.57E-06	1.49E-06	0.00E+00	0.00	1.21E-06	6.03E-05	7.57E-09	-2.59E-09	4.81E-07		-2.59E-05
ADP fossil fuels	MJ Hu	237.70	24.18	20.05	0.00	20.04	5.18	7.03	0.09	-0.05	6.46	-348.05	
WDP	m3 world equiv deprived	4.99	0.07	0.07	0.00	0.07	0.02	0.09	0.00	0.00	0.03	-1.83	
Legend	GWP = Global warming potential; luluc = Land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP = Abiotic depletion potential; WDP = Water deprivation potential (users)												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 30: Results of additional environmental impact indicators per metre [m] of 118/7.5 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PM	Disease incidence	2.66E-06	1.27E-07	3.77E-07	0.00E+00	3.77E-07	2.76E-08	8.13E-08	6.28E-10	-6.31E-11	4.27E-08		-2.30E-06
IRP	kBq U235 equiv	8.96E-01	1.24E-01	9.84E-02	0.00E+00	9.84E-02	2.67E-02	7.20E-02	4.12E-04	-2.06E-04	1.14E-02		-6.16E-01
ETP-fw	CTUe	325.69	18.87	13.78	0.00	13.78	4.07	25.78	0.06	-0.03	19.12		-1030.14
HTP-c	CTUh	2.06E-08	6.25E-10	1.13E-09	0.00E+00	1.13E-09	1.31E-10	8.69E-10	1.48E-12	-5.49E-13	3.41E-09		-1.84E-07
HTP-nc	CTUh	1.79E-07	1.89E-08	1.07E-08	0.00E+00	1.07E-08	4.11E-09	3.81E-08	3.85E-11	-1.54E-11	1.31E-08		-7.08E-07
SQP	Points	49.68	16.49	2.71	0.00	2.71	3.61	12.97	0.19	-4.01E-03	1.26		-67.97
Legend	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems - freshwater; HTP-c = Potential toxicity comparison unit for humans - carcinogenic effect; HTP-nc = Potential toxicity comparison unit for humans - non-carcinogenic effect; SQP = Potential soil quality index												

D* from C3 shows the recycling potential without taking into account the net flow rule according to OENORM EN 15804

Table 31: Results of parameters describing resource use per metre [m] of 118/7.5 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PERE	MJ H _u	27.69	0.34	0.36	0.00	0.25	0.07	1.09	7.91E-04	-2.08E-03	0.13		-7.16
PERM	MJ H _u	0.12	0.00	-0.12	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PERT	MJ H _u	27.81	0.34	0.25	0.00	0.25	0.07	1.09	7.91E-04	-2.08E-03	0.13		-7.16
PENRE	MJ H _u	237.69	24.18	20.05	0.00	20.04	5.18	7.03	9.27E-02	-4.56E-02	6.46		-348.06
PENRM	MJ H _u	6.75E-03	0.00	-6.75E-03	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PENRT	MJ H _u	237.69	24.18	20.05	0.00	20.04	5.18	7.03	9.27E-02	-4.56E-02	6.46		-348.06
SM	kg	20.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.38		0.00
RSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
NRSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
FW	m ³	1.96E-01	2.65E-03	2.33E-03	0.00E+00	2.33E-03	5.77E-04	3.58E-03	9.84E-05	-1.32E-05	1.10E-03		-5.93E-02
Legend	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy resources as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of fresh water												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 32: Results of waste categories and output flows per metre [m] of 118/7.5 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
HWD	kg	2.78E-04	6.20E-05	5.75E-05	0.00E+00	5.75E-05	1.35E-05	2.02E-05	1.40E-07	-3.45E-08	6.90E-05		-3.72E-03
NHWD	kg	1.74	1.23	0.06	0.00	0.06	0.27	0.22	0.63	0.00	0.02		-1.14
RWD	kg	8.37E-04	3.26E-04	2.61E-04	0.00E+00	2.61E-04	6.98E-05	8.04E-05	1.21E-06	-1.08E-07	1.33E-05		-7.18E-04
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
MFR	kg	0.00	0.00	0.00	0.00	0.00	0.00	20.37	0.00	0.00	0.00		0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
EEE	MJ	0.00E+00	0.00E+00	6.93E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
EET	MJ	0.00E+00	0.00E+00	6.11E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
Legend	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electric energy; EET = Exported thermal energy												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 33: Results of description of biogenic carbon content at the gate per metre [m] of 118/7.5 mm piling system

Results compliant with EN 15804											
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3
C content product	kg C	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C content packaging	kg C	3.82E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Legend	C content product = biogenic carbon content in the product; C content packaging = biogenic carbon content in the associated packaging										

C content beech wood = 46.3%, beech wood packaging = 8.26E-03 kg/m

5.4 118/9 mm TRM piling system

Table 34: Results of parameters describing the environmental impact per metre [m] of 118/9 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
GWP total	kg CO2 equiv	23.70	1.87	1.48	0.00	1.47	0.40	0.58	3.85E-03	-3.62E-03	0.74		-39.91
GWP fossil	kg CO2 equiv	23.56	1.86	1.47	0.00	1.47	0.40	0.59	3.84E-03	-3.61E-03	0.74		-40.03
GWP biogenic	kg CO2 equiv	1.26E-01	1.55E-03	1.52E-02	0.00E+00	1.21E-03	3.43E-04	-1.04E-02	3.81E-06	-8.92E-06	-2.33E-03		1.25E-01
GWP luluc	kg CO2 equiv	7.08E-03	7.65E-04	2.54E-04	0.00E+00	2.54E-04	1.59E-04	1.13E-03	3.63E-06	-3.10E-06	2.10E-04		-1.13E-02
ODP	kg CFC-11 equiv	1.22E-06	4.30E-07	2.93E-07	0.00E+00	0.00	9.22E-08	7.86E-08	1.56E-09	-2.48E-10	2.97E-08		-1.60E-06
AP	mol H+ equiv	5.72E-02	7.04E-03	1.43E-02	0.00E+00	0.01	1.13E-03	7.05E-03	3.62E-05	-1.12E-05	2.70E-03		-1.45E-01
EP freshwater	kg P equiv	8.67E-03	1.20E-04	1.06E-04	0.00E+00	0.00	2.61E-05	3.75E-04	3.52E-07	-7.72E-07	2.94E-04		-1.58E-02
EP saltwater	kg N equiv	1.46E-02	1.51E-03	6.22E-03	0.00E+00	0.01	2.29E-04	1.60E-03	1.26E-05	-2.24E-06	6.40E-04		-3.45E-02
EP land	mol N equiv	1.49E-01	1.66E-02	6.80E-02	0.00E+00	0.07	2.50E-03	1.79E-02	1.38E-04	-2.30E-05	6.79E-03		-3.66E-01
POCP	kg NMVOC equiv	4.72E-02	5.72E-03	1.89E-02	0.00E+00	0.02	9.62E-04	4.94E-03	4.00E-05	-6.80E-06	3.73E-03		-2.01E-01
ADP minerals and metals	kg Sb equiv	4.31E-05	6.48E-06	1.49E-06	0.00E+00	0.00	1.41E-06	7.01E-05	8.77E-09	-3.01E-09	5.60E-07	-3.02E-05	
ADP fossil fuels	MJ Hu	276.41	28.11	20.05	0.00	20.04	6.03	8.17	0.11	-0.05	7.52	-404.78	
WDP	m3 world equiv deprived	5.80	0.08	0.07	0.00	0.07	0.02	0.11	0.00	0.00	0.04	-2.13	
Legend	GWP = Global warming potential; luluc = Land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP = Abiotic depletion potential; WDP = Water deprivation potential (users)												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 35: Results of additional environmental impact indicators per metre [m] of 118/9 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PM	Disease incidence	3.09E-06	1.47E-07	3.77E-07	0.00E+00	3.77E-07	3.21E-08	9.46E-08	7.28E-10	-7.34E-11	4.97E-08		-2.68E-06
IRP	kBq U235 equiv	1.04E+00	1.44E-01	9.84E-02	0.00E+00	9.84E-02	3.11E-02	8.38E-02	4.77E-04	-2.39E-04	1.33E-02		-7.16E-01
ETP-fw	CTUe	378.73	21.93	13.78	0.00	13.78	4.73	29.99	0.07	-0.04	22.25		-1198.03
HTP-c	CTUh	2.39E-08	7.26E-10	1.13E-09	0.00E+00	1.13E-09	1.52E-10	1.01E-09	1.72E-12	-6.39E-13	3.97E-09		-2.14E-07
HTP-nc	CTUh	2.08E-07	2.20E-08	1.07E-08	0.00E+00	1.07E-08	4.78E-09	4.43E-08	4.46E-11	-1.79E-11	1.53E-08		-8.23E-07
SQP	Points	57.77	19.17	2.71	0.00	2.71	4.20	15.09	0.23	-4.66E-03	1.47		-79.05
Legend	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems - freshwater; HTP-c = Potential toxicity comparison unit for humans - carcinogenic effect; HTP-nc = Potential toxicity comparison unit for humans - non-carcinogenic effect; SQP = Potential soil quality index												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 36: Results of parameters describing resource use per metre [m] of 118/9 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PERE	MJ H _u	32.20	0.40	0.38	0.00	0.25	0.09	1.27	9.16E-04	-2.42E-03	0.15		-8.33
PERM	MJ H _u	0.13	0.00	-0.13	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PERT	MJ H _u	32.34	0.40	0.25	0.00	0.25	0.09	1.27	9.16E-04	-2.42E-03	0.15		-8.33
PENRE	MJ H _u	276.40	28.11	20.05	0.00	20.04	6.03	8.17	1.07E-01	-5.30E-02	7.52		-404.79
PENRM	MJ H _u	7.85E-03	0.00	-7.85E-03	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PENRT	MJ H _u	276.40	28.11	20.05	0.00	20.04	6.03	8.17	1.07E-01	-5.30E-02	7.52		-404.79
SM	kg	24.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.44		0.00
RSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
NRSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
FW	m ³	2.28E-01	1.82E-03	2.33E-03	0.00E+00	2.33E-03	6.70E-04	4.16E-03	1.14E-04	-1.54E-05	1.28E-03		-6.90E-02
Legend	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy resources as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of fresh water												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 37: Results of waste categories and output flows per metre [m] of 118/9 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
HWD	kg	3.23E-04	7.21E-05	5.75E-05	0.00E+00	5.75E-05	1.57E-05	2.35E-05	1.62E-07	-4.01E-08	8.03E-05		-4.32E-03
NHWD	kg	2.02	1.43	0.06	0.00	0.06	0.32	0.25	0.73	0.00	0.02		-1.33
RWD	kg	9.73E-04	3.79E-04	2.61E-04	0.00E+00	2.61E-04	8.12E-05	9.35E-05	1.40E-06	-1.25E-07	1.55E-05		-8.35E-04
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
MFR	kg	0.00	0.00	0.00	0.00	0.00	0.00	23.69	0.00	0.00	0.00		0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
EEE	MJ	0.00E+00	0.00E+00	8.06E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
EET	MJ	0.00E+00	0.00E+00	7.11E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
Legend	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electric energy; EET = Exported thermal energy												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 38: Results of description of biogenic carbon content at the gate per metre [m] of 118/9 mm piling system

Results compliant with EN 15804											
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3
C content product	kg C	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C content packaging	kg C	4.44E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Legend	C content product = biogenic carbon content in the product; C content packaging = biogenic carbon content in the associated packaging										

C content beech wood = 46.3%, beech wood packaging = 9.60E-03 kg/m

5.5 118/10.6 mm TRM piling system

Table 39: Results of parameters describing the environmental impact per metre [m] of 118/10.6 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
GWP total	kg CO2 equiv	27.13	2.14	1.49	0.00	1.47	0.46	0.67	4.43E-03	-4.15E-03	0.85		-45.69
GWP fossil	kg CO2 equiv	26.98	2.13	1.47	0.00	1.47	0.46	0.68	4.42E-03	-4.13E-03	0.85		-45.82
GWP biogenic	kg CO2 equiv	0.14	0.00	0.02	1.00	0.00	0.00	-0.01	4.38E-06	-1.02E-05	0.00		0.14
GWP luluc	kg CO2 equiv	8.11E-03	8.76E-04	2.54E-04	0.00E+00	2.54E-04	1.82E-04	1.29E-03	4.18E-06	-3.54E-06	2.41E-04		-1.30E-02
ODP	kg CFC-11 equiv	1.40E-06	4.92E-07	2.93E-07	0.00E+00	0.00	1.06E-07	9.00E-08	1.79E-09	-2.84E-10	3.39E-08		-1.83E-06
AP	mol H+ equiv	6.55E-02	8.07E-03	1.43E-02	0.00E+00	0.01	1.29E-03	8.07E-03	4.16E-05	-1.28E-05	3.08E-03		-1.66E-01
EP freshwater	kg P equiv	9.93E-03	1.38E-04	1.06E-04	0.00E+00	0.00	2.98E-05	4.29E-04	4.05E-07	-8.84E-07	3.36E-04		-1.81E-02
EP saltwater	kg N equiv	1.67E-02	1.73E-03	6.22E-03	0.00E+00	0.01	2.63E-04	1.83E-03	1.45E-05	-2.56E-06	7.31E-04		-3.94E-02
EP land	mol N equiv	1.70E-01	1.90E-02	6.80E-02	0.00E+00	0.07	2.86E-03	2.05E-02	1.58E-04	-2.63E-05	7.76E-03		-4.18E-01
POCP	kg NMVOC equiv	5.40E-02	6.55E-03	1.89E-02	0.00E+00	0.02	1.10E-03	5.65E-03	4.61E-05	-7.78E-06	4.27E-03		-2.30E-01
ADP minerals and metals	kg Sb equiv	4.93E-05	7.42E-06	1.49E-06	0.00E+00	0.00	1.61E-06	8.03E-05	1.01E-08	-3.45E-09	6.41E-07		-3.45E-05
ADP fossil fuels	MJ Hu	316.48	32.20	20.05	0.00	20.04	6.90	9.36	0.12	-0.06	8.59	-463.38	
WDP	m3 world equiv deprived	6.64	0.10	0.07	1.00	0.07	0.02	0.12	0.01	0.00	0.05	-2.43	
Legend	GWP = Global warming potential; luluc = Land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP = Abiotic depletion potential; WDP = Water deprivation potential (users)												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 40: Results of additional environmental impact indicators per metre [m] of 118/10.6 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PM	Disease incidence	3.54E-06	1.69E-07	3.77E-07	0.00E+00	3.77E-07	3.67E-08	1.08E-07	8.38E-10	-8.40E-11	5.69E-08		-3.07E-06
IRP	kBq U235 equiv	1.19E+00	1.65E-01	9.84E-02	0.00E+00	9.84E-02	3.56E-02	9.59E-02	5.49E-04	-2.74E-04	1.52E-02		-8.20E-01
ETP-fw	CTUe	433.64	25.12	13.78	0.00	13.78	5.42	34.33	0.08	-0.04	25.44		-1371.49
HTP-c	CTUh	2.74E-08	8.32E-10	1.13E-09	0.00E+00	1.13E-09	1.74E-10	1.16E-09	1.98E-12	-7.31E-13	4.54E-09		-2.45E-07
HTP-nc	CTUh	2.39E-07	2.52E-08	1.07E-08	0.00E+00	1.07E-08	5.48E-09	5.07E-08	5.13E-11	-2.04E-11	1.75E-08		-9.42E-07
SQP	Points	66.15	21.95	2.71	0.00	2.71	4.81	17.27	0.26	-5.33E-03	1.68		-90.49
Legend	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems - freshwater; HTP-c = Potential toxicity comparison unit for humans - carcinogenic effect; HTP-nc = Potential toxicity comparison unit for humans - non-carcinogenic effect; SQP = Potential soil quality index												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 41: Results of parameters describing resource use per metre [m] of 118/10.6 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PERE	MJ H _u	36.87	0.45	0.40	0.00	0.25	0.10	1.45	1.05E-03	-2.77E-03	0.18		-9.54
PERM	MJ H _u	0.15	0.00	-0.15	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PERT	MJ H _u	37.03	0.45	0.25	0.00	0.25	0.10	1.45	1.05E-03	-2.77E-03	0.18		-9.54
PENRE	MJ H _u	316.46	32.20	20.06	0.00	20.04	6.90	9.36	1.24E-01	-6.07E-02	8.59		-463.40
PENRM	MJ H _u	8.98E-03	0.00	-8.98E-03	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PENRT	MJ H _u	316.47	32.20	20.05	0.00	20.04	6.90	9.36	1.24E-01	-6.07E-02	8.59		-463.40
SM	kg	27.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.50		0.00
RSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
NRSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
FW	m ³	2.61E-01	3.53E-03	2.33E-03	0.00E+00	2.33E-03	7.68E-04	4.76E-03	1.31E-04	-1.76E-05	1.46E-03		-7.90E-02
Legend	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy resources as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of fresh water												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 42: Results of waste categories and output flows per metre [m] of 118/10.6 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
HWD	kg	3.70E-04	7.21E-05	5.75E-05	0.00E+00	5.75E-05	1.57E-05	2.35E-05	1.62E-07	-4.01E-08	8.03E-05		-4.32E-03
NHWD	kg	2.32	1.43	0.06	0.00	0.06	0.32	0.25	0.73	0.00	0.02		-1.33
RWD	kg	1.11E-03	3.79E-04	2.61E-04	0.00E+00	2.61E-04	8.12E-05	9.35E-05	1.40E-06	-1.25E-07	1.55E-05		-8.35E-04
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
MFR	kg	0.00	0.00	0.00	0.00	0.00	0.00	27.12	0.00	0.00	0.00		0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
EEE	MJ	0.00E+00	0.00E+00	9.22E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
EET	MJ	0.00E+00	0.00E+00	8.14E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
Legend	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electric energy; EET = Exported thermal energy												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 43: Results of description of biogenic carbon content at the gate per metre [m] of 118/10.6 mm piling system

Results compliant with EN 15804											
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3
C content product	kg C	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C content packaging	kg C	5.09E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Legend	C content product = biogenic carbon content in the product; C content packaging = biogenic carbon content in the associated packaging										

C content beech wood = 46.3%, beech wood packaging = 1.10E-02 kg/m

5.6 170/7.5 mm TRM piling system

Table 44: Results of parameters describing the environmental impact per metre [m] of 170/7.5 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
GWP total	kg CO2 equiv	32.80	2.58	1.49	0.00	1.47	0.55	0.81	5.33E-03	-5.00E-03	1.02		-55.25
GWP fossil	kg CO2 equiv	32.61	2.58	1.47	0.00	1.47	0.55	0.82	5.32E-03	-4.99E-03	1.03		-55.40
GWP biogenic	kg CO2 equiv	1.75E-01	2.15E-03	2.06E-02	0.00E+00	1.21E-03	4.75E-04	-1.44E-02	5.27E-06	-1.23E-05	-3.22E-03		1.74E-01
GWP luluc	kg CO2 equiv	9.80E-03	1.06E-03	2.54E-04	0.00E+00	2.54E-04	2.20E-04	1.56E-03	5.02E-06	-4.27E-06	2.91E-04		-1.57E-02
ODP	kg CFC-11 equiv	1.69E-06	5.95E-07	2.93E-07	0.00E+00	0.00	1.28E-07	1.09E-07	2.15E-09	-3.43E-10	4.10E-08		-2.21E-06
AP	mol H+ equiv	7.92E-02	9.75E-03	1.43E-02	0.00E+00	0.01	1.56E-03	9.75E-03	5.00E-05	-1.54E-05	3.73E-03		-2.01E-01
EP freshwater	kg P equiv	1.20E-02	1.66E-04	1.06E-04	0.00E+00	0.00	3.61E-05	5.19E-04	4.87E-07	-1.06E-06	4.06E-04		-2.19E-02
EP saltwater	kg N equiv	2.02E-02	2.09E-03	6.22E-03	0.00E+00	0.01	3.18E-04	2.21E-03	1.74E-05	-3.09E-06	8.84E-04		-4.77E-02
EP land	mol N equiv	2.06E-01	2.30E-02	6.80E-02	0.00E+00	0.07	3.46E-03	2.48E-02	1.90E-04	-3.17E-05	9.38E-03		-5.06E-01
POCP	kg NMVOC equiv	6.53E-02	7.92E-03	1.89E-02	0.00E+00	0.02	1.33E-03	6.83E-03	5.54E-05	-9.39E-06	5.16E-03		-2.78E-01
ADP minerals and metals	kg Sb equiv	5.96E-05	8.97E-06	1.49E-06	0.00E+00	0.00	1.95E-06	9.71E-05	1.21E-08	-4.16E-09	7.74E-07		-4.18E-05
ADP fossil fuels	MJ Hu	382.58	38.92	20.05	0.00	20.04	8.35	11.31	0.15	-0.07	10.39	-560.26	
WDP	m3 world equiv deprived	8.03	0.12	0.07	0.00	0.07	0.03	0.15	0.01	0.00	0.05	-2.94	
Legend	GWP = Global warming potential; luluc = Land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP = Abiotic depletion potential; WDP = Water deprivation potential (users)												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 45: Results of additional environmental impact indicators per metre [m] of 170/7.5 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PM	Disease incidence	4.28E-06	2.04E-07	3.77E-07	0.00E+00	3.77E-07	4.44E-08	1.31E-07	1.01E-09	-1.01E-10	6.87E-08		-3.71E-06
IRP	kBq U235 equiv	1.44E+00	2.00E-01	9.84E-02	0.00E+00	9.84E-02	4.30E-02	1.16E-01	6.60E-04	-3.29E-04	1.84E-02		-9.92E-01
ETP-fw	CTUe	524.21	30.37	13.78	0.00	13.78	6.55	41.50	0.09	-0.05	30.75		-1658.23
HTP-c	CTUh	3.31E-08	1.01E-09	1.13E-09	0.00E+00	1.13E-09	2.11E-10	1.40E-09	2.38E-12	-8.82E-13	5.49E-09		-2.96E-07
HTP-nc	CTUh	2.88E-07	3.05E-08	1.07E-08	0.00E+00	1.07E-08	6.62E-09	6.13E-08	6.17E-11	-2.46E-11	2.11E-08		-1.14E-06
SQP	Points	79.96	26.54	2.71	0.00	2.71	5.82	20.88	0.31	-6.43E-03	2.03		-109.41
Legend	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems - freshwater; HTP-c = Potential toxicity comparison unit for humans - carcinogenic effect; HTP-nc = Potential toxicity comparison unit for humans - non-carcinogenic effect; SQP = Potential soil quality index												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 46: Results of parameters describing resource use per metre [m] of 170/7.5 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PERE	MJ H _u	44.58	0.55	0.43	0.00	0.25	0.12	1.76	1.27E-03	-3.34E-03	0.21		-11.53
PERM	MJ H _u	0.19	0.00	-0.19	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PERT	MJ H _u	44.76	0.55	0.25	0.00	0.25	0.12	1.76	1.27E-03	-3.34E-03	0.21		-11.53
PENRE	MJ H _u	382.56	38.92	20.06	0.00	20.04	8.35	11.32	1.49E-01	-7.33E-02	10.39		-560.29
PENRM	MJ H _u	1.09E-02	0.00	-1.09E-02	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PENRT	MJ H _u	382.58	38.92	20.05	0.00	20.04	8.35	11.32	1.49E-01	-7.33E-02	10.39		-560.29
SM	kg	33.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.61		0.00
RSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
NRSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
FW	m ³	3.15E-01	4.27E-03	2.33E-03	0.00E+00	2.33E-03	9.28E-04	5.76E-03	1.58E-04	-2.12E-05	1.77E-03		-9.55E-02
Legend	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy resources as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of fresh water												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 47: Results of waste categories and output flows per metre [m] of 170/7.5 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
HWD	kg	4.47E-04	9.98E-05	5.75E-05	0.00E+00	5.75E-05	2.18E-05	3.26E-05	2.25E-07	-5.55E-08	1.11E-04		-5.98E-03
NHWD	kg	2.80	1.99	0.06	0.00	0.06	0.44	0.35	1.01	0.00	0.03		-1.84
RWD	kg	1.35E-03	5.24E-04	2.61E-04	0.00E+00	2.61E-04	1.12E-04	1.29E-04	1.94E-06	-1.73E-07	2.14E-05		-1.16E-03
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
MFR	kg	0.00	0.00	0.00	0.00	0.00	0.00	32.79	0.00	0.00	0.00		0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
EEE	MJ	0.00E+00	0.00E+00	6.93E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
EET	MJ	0.00E+00	0.00E+00	6.11E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
Legend	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electric energy; EET = Exported thermal energy												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 48: Results of description of biogenic carbon content at the gate per metre [m] of 170/7.5 mm piling system

Results compliant with EN 15804											
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3
C content product	kg C	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C content packaging	kg C	6.15E-03	0.00E+00	-6.15E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Legend	C content product = biogenic carbon content in the product; C content packaging = biogenic carbon content in the associated packaging										

C content beech wood = 46.3%, beech wood packaging = 1.33E-02 kg/m

5.7 170/9 mm TRM piling system

Table 49: Results of parameters describing the environmental impact per metre [m] of 170/9 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
GWP total	kg CO2 equiv	36.04	2.84	1.49	0.00	1.47	0.61	0.89	5.86E-03	-5.52E-03	1.13		-60.71
GWP fossil	kg CO2 equiv	35.83	2.84	1.47	0.00	1.47	0.60	0.90	5.85E-03	-5.50E-03	1.13		-60.88
GWP biogenic	kg CO2 equiv	0.19	0.00	0.02	1.00	0.00	0.00	-0.02	5.79E-06	-1.36E-05	0.00		0.19
GWP luluc	kg CO2 equiv	1.08E-02	1.16E-03	2.54E-04	0.00E+00	2.54E-04	2.42E-04	1.72E-03	5.52E-06	-4.73E-06	3.20E-04		-1.72E-02
ODP	kg CFC-11 equiv	1.86E-06	6.54E-07	2.93E-07	0.00E+00	0.00	1.40E-07	1.20E-07	2.36E-09	-3.77E-10	4.51E-08		-2.43E-06
AP	mol H+ equiv	8.70E-02	1.07E-02	1.43E-02	0.00E+00	0.01	1.72E-03	1.07E-02	5.50E-05	-1.70E-05	4.10E-03		-2.21E-01
EP freshwater	kg P equiv	1.32E-02	1.83E-04	1.06E-04	0.00E+00	0.00	3.96E-05	5.71E-04	5.35E-07	-1.18E-06	4.46E-04		-2.40E-02
EP saltwater	kg N equiv	2.22E-02	2.30E-03	6.22E-03	0.00E+00	0.01	3.49E-04	2.43E-03	1.91E-05	-3.41E-06	9.73E-04		-5.24E-02
EP land	mol N equiv	2.26E-01	2.52E-02	6.80E-02	0.00E+00	0.07	3.80E-03	2.72E-02	2.09E-04	-3.50E-05	1.03E-02		-5.56E-01
POCP	kg NMVOC equiv	7.18E-02	8.70E-03	1.89E-02	0.00E+00	0.02	1.46E-03	7.51E-03	6.09E-05	-1.04E-05	5.68E-03		-3.06E-01
ADP minerals and metals	kg Sb equiv	6.55E-05	9.86E-06	1.49E-06	0.00E+00	0.00	2.14E-06	1.07E-04	1.33E-08	-4.59E-09	8.52E-07		-4.59E-05
ADP fossil fuels	MJ Hu	420.39	42.77	20.05	0.00	20.04	9.17	12.43	0.16	-0.08	11.43	-615.62	
WDP	m3 world equiv deprived	8.82	0.13	0.07	1.00	0.07	0.03	0.16	0.01	0.00	0.06	-3.23	
Legend	GWP = Global warming potential; luluc = Land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP = Abiotic depletion potential; WDP = Water deprivation potential (users)												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 50: Results of additional environmental impact indicators per metre [m] of 170/9 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PM	Disease incidence	4.70E-06	2.24E-07	3.77E-07	0.00E+00	3.77E-07	4.87E-08	1.44E-07	1.11E-09	-1.12E-10	7.56E-08		-4.07E-06
IRP	kBq U235 equiv	1.58E+00	2.20E-01	9.84E-02	0.00E+00	9.84E-02	4.72E-02	1.27E-01	7.25E-04	-3.65E-04	2.02E-02		-1.09E+00
ETP-fw	CTUe	576.01	33.38	13.78	0.00	13.78	7.20	45.60	0.10	-0.05	33.83		-1822.08
HTP-c	CTUh	3.64E-08	1.10E-09	1.13E-09	0.00E+00	1.13E-09	2.31E-10	1.54E-09	2.62E-12	-9.73E-13	6.04E-09		-3.25E-07
HTP-nc	CTUh	3.17E-07	3.35E-08	1.07E-08	0.00E+00	1.07E-08	7.27E-09	6.74E-08	6.78E-11	-2.72E-11	2.32E-08		-1.25E-06
SQP	Points	87.87	29.17	2.71	0.00	2.71	6.39	22.95	0.34	-7.10E-03	2.23	-120.22	
Legend	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems - freshwater; HTP-c = Potential toxicity comparison unit for humans - carcinogenic effect; HTP-nc = Potential toxicity comparison unit for humans - non-carcinogenic effect; SQP = Potential soil quality index												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 51: Results of parameters describing resource use per metre [m] of 170/9 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PERE	MJ H _u	48.98	0.60	0.45	0.00	0.25	0.13	1.93	1.39E-03	-3.70E-03	0.24		-12.67
PERM	MJ H _u	0.20	0.00	-0.20	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PERT	MJ H _u	49.18	0.60	0.25	0.00	0.25	0.13	1.93	1.39E-03	-3.70E-03	0.24		-12.67
PENRE	MJ H _u	420.37	42.78	20.06	0.00	20.04	9.17	12.43	1.63E-01	-8.07E-02	11.43		-615.65
PENRM	MJ H _u	1.19E-02	0.00	-1.19E-02	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PENRT	MJ H _u	420.38	42.78	20.05	0.00	20.04	9.17	12.43	1.63E-01	-8.07E-02	11.43		-615.65
SM	kg	36.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.67		0.00
RSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
NRSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
FW	m ³	3.46E-01	4.69E-03	2.34E-03	0.00E+00	2.33E-03	1.02E-03	6.33E-03	1.73E-04	-2.34E-05	1.95E-03		-1.05E-01
Legend	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy resources as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of fresh water												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 52: Results of waste categories and output flows per metre [m] of 170/9 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
HWD	kg	4.91E-04	7.21E-05	5.75E-05	0.00E+00	5.75E-05	1.57E-05	2.35E-05	1.62E-07	-4.01E-08	8.03E-05		-4.32E-03
NHWD	kg	3.08	1.43	0.06	0.00	0.06	0.32	0.25	0.73	0.00	0.02		-1.33
RWD	kg	1.48E-03	3.79E-04	2.61E-04	0.00E+00	2.61E-04	8.12E-05	9.35E-05	1.40E-06	-1.25E-07	1.55E-05		-8.35E-04
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
MFR	kg	0.00	0.00	0.00	0.00	0.00	0.00	36.03	0.00	0.00	0.00		0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
EEE	MJ	0.00E+00	0.00E+00	1.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
EET	MJ	0.00E+00	0.00E+00	1.08E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
Legend	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electric energy; EET = Exported thermal energy												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 53: Results of description of biogenic carbon content at the gate per metre [m] of 170/9 mm piling system

Results compliant with EN 15804											
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3
C content product	kg C	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C content packaging	kg C	6.76E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Legend	C content product = biogenic carbon content in the product; C content packaging = biogenic carbon content in the associated packaging										

C content beech wood = 46.3%, beech wood packaging = 1.46E-02 kg/m

5.8 170/10.6 mm TRM piling system

Table 54: Results of parameters describing the environmental impact per metre [m] of 170/10.6 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
GWP total	kg CO2 equiv	41.28	3.25	1.49	0.00	1.47	0.69	1.01	6.75E-03	-6.98E-03	1.29		-69.52
GWP fossil	kg CO2 equiv	41.04	3.25	1.47	0.00	1.47	0.69	1.03	6.74E-03	-6.95E-03	1.29		-69.71
GWP biogenic	kg CO2 equiv	0.22	0.00	0.03	1.00	0.00	0.00	-0.02	6.68E-06	-1.72E-05	0.00		0.22
GWP luluc	kg CO2 equiv	1.23E-02	1.33E-03	2.54E-04	0.00E+00	2.54E-04	2.77E-04	1.97E-03	6.37E-06	-5.96E-06	3.66E-04		-1.97E-02
ODP	kg CFC-11 equiv	2.13E-06	7.49E-07	2.93E-07	0.00E+00	0.00	1.61E-07	1.37E-07	2.73E-09	-4.78E-10	5.17E-08		-2.78E-06
AP	mol H+ equiv	9.97E-02	1.23E-02	1.43E-02	0.00E+00	0.01	1.97E-03	1.23E-02	6.34E-05	-2.15E-05	4.70E-03		-2.53E-01
EP freshwater	kg P equiv	1.51E-02	2.09E-04	1.06E-04	0.00E+00	0.00	4.54E-05	6.53E-04	6.17E-07	-1.49E-06	5.11E-04		-2.75E-02
EP saltwater	kg N equiv	2.54E-02	2.64E-03	6.22E-03	0.00E+00	0.01	4.00E-04	2.78E-03	2.20E-05	-4.31E-06	1.11E-03		-6.00E-02
EP land	mol N equiv	2.59E-01	2.89E-02	6.80E-02	0.00E+00	0.07	4.36E-03	3.11E-02	2.41E-04	-4.42E-05	1.18E-02		-6.37E-01
POCP	kg NMVOC equiv	8.22E-02	9.97E-03	1.89E-02	0.00E+00	0.02	1.68E-03	8.60E-03	7.02E-05	-1.31E-05	6.50E-03		-3.50E-01
ADP minerals and metals	kg Sb equiv	7.50E-05	1.13E-05	1.49E-06	0.00E+00	0.00	2.46E-06	1.22E-04	1.54E-08	-5.80E-09	9.76E-07	-5.25E-05	
ADP fossil fuels	MJ Hu	481.51	48.99	20.05	0.00	20.04	10.50	14.23	0.19	-0.10	13.09	-704.98	
WDP	m3 world equiv deprived	10.10	0.15	0.07	1.00	0.07	0.03	0.19	0.01	0.00	0.07	-3.70	
Legend	GWP = Global warming potential; luluc = Land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP = Abiotic depletion potential; WDP = Water deprivation potential (users)												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 55: Results of additional environmental impact indicators per metre [m] of 170/10.6 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PM	Disease incidence	5.39E-06	2.57E-07	3.77E-07	0.00E+00	3.77E-07	5.58E-08	1.65E-07	1.28E-09	-1.41E-10	8.66E-08		-4.66E-06
IRP	kBq U235 equiv	1.82E+00	2.52E-01	9.84E-02	0.00E+00	9.84E-02	5.41E-02	1.46E-01	8.36E-04	-4.60E-04	2.32E-02		-1.25E+00
ETP-fw	CTUe	659.76	38.23	13.78	0.00	13.78	8.24	52.22	0.12	-0.07	38.74		-2086.57
HTP-c	CTUh	4.17E-08	1.27E-09	1.13E-09	0.00E+00	1.13E-09	2.65E-10	1.76E-09	3.02E-12	-1.23E-12	6.92E-09		-3.73E-07
HTP-nc	CTUh	3.63E-07	3.83E-08	1.07E-08	0.00E+00	1.07E-08	8.33E-09	7.72E-08	7.82E-11	-3.44E-11	2.66E-08		-1.43E-06
SQP	Points	100.64	33.41	2.71	0.00	2.71	7.32	26.28	0.40	-8.97E-03	2.56	-137.67	
Legend	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems - freshwater; HTP-c = Potential toxicity comparison unit for humans - carcinogenic effect; HTP-nc = Potential toxicity comparison unit for humans - non-carcinogenic effect; SQP = Potential soil quality index												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 56: Results of parameters describing resource use per metre [m] of 170/10.6 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PERE	MJ H _u	56.10	0.69	0.48	0.00	0.25	0.15	2.21	1.61E-03	-4.66E-03	0.27		-14.51
PERM	MJ H _u	0.23	0.00	-0.23	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PERT	MJ H _u	56.34	0.69	0.25	0.00	0.25	0.15	2.21	1.61E-03	-4.66E-03	0.27		-14.51
PENRE	MJ H _u	481.46	48.99	20.09	0.00	20.04	10.50	14.24	1.88E-01	-1.02E-01	13.09		-705.01
PENRM	MJ H _u	3.97E-02	0.00	-3.97E-02	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PENRT	MJ H _u	481.50	48.99	20.05	0.00	20.04	10.50	14.24	1.88E-01	-1.02E-01	13.09		-705.01
SM	kg	42.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.77		0.00
RSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
NRSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
FW	m ³	3.97E-01	5.37E-03	2.34E-03	0.00E+00	2.33E-03	1.17E-03	7.24E-03	2.00E-04	-2.96E-05	2.23E-03		-1.20E-01
Legend	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy resources as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of fresh water												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 57: Results of waste categories and output flows per metre [m] of 170/10.6 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
HWD	kg	5.62E-04	7.21E-05	5.75E-05	0.00E+00	5.75E-05	1.57E-05	2.35E-05	1.62E-07	-4.01E-08	8.03E-05		-4.32E-03
NHWD	kg	3.52	1.43	0.06	0.00	0.06	0.32	0.25	0.73	0.00	0.02		-1.33
RWD	kg	1.70E-03	3.79E-04	2.61E-04	0.00E+00	2.61E-04	8.12E-05	9.35E-05	1.40E-06	-1.25E-07	1.55E-05		-8.35E-04
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
MFR	kg	0.00	0.00	0.00	0.00	0.00	0.00	41.26	0.00	0.00	0.00		0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
EEE	MJ	0.00E+00	0.00E+00	1.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
EET	MJ	0.00E+00	0.00E+00	1.37E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
Legend	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electric energy; EET = Exported thermal energy												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 58: Results of description of biogenic carbon content at the gate per metre [m] of 170/10.6 mm piling system

Results compliant with EN 15804											
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3
C content product	kg C	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C content packaging	kg C	7.73E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Legend	C content product = biogenic carbon content in the product; C content packaging = biogenic carbon content in the associated packaging										

C content beech wood = 46.3%, beech wood packaging = 1.67E-02 kg/m

5.9 170/13 mm TRM piling system

Table 59: Results of parameters describing the environmental impact per metre [m] of 170/13 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
GWP total	kg CO2 equiv	48.93	3.85	1.50	0.00	1.47	0.82	1.20	7.97E-03	-7.48E-03	1.53		-82.41
GWP fossil	kg CO2 equiv	48.64	3.85	1.47	0.00	1.47	0.82	1.22	7.95E-03	-7.45E-03	1.53		-82.64
GWP biogenic	kg CO2 equiv	0.26	0.00	0.03	1.00	0.00	0.00	-0.02	7.88E-06	-1.84E-05	0.00		0.26
GWP luluc	kg CO2 equiv	1.46E-02	1.58E-03	2.54E-04	0.00E+00	2.54E-04	3.28E-04	2.33E-03	7.51E-06	-6.38E-06	4.34E-04		-2.34E-02
ODP	kg CFC-11 equiv	2.52E-06	8.88E-07	2.93E-07	0.00E+00	0.00	1.90E-07	1.62E-07	3.22E-09	-5.13E-10	6.13E-08		-3.30E-06
AP	mol H+ equiv	1.18E-01	1.45E-02	1.43E-02	0.00E+00	0.01	2.33E-03	1.45E-02	7.48E-05	-2.30E-05	5.57E-03		-3.00E-01
EP freshwater	kg P equiv	1.79E-02	2.48E-04	1.07E-04	0.00E+00	0.00	5.38E-05	7.74E-04	7.28E-07	-1.59E-06	6.06E-04		-3.26E-02
EP saltwater	kg N equiv	3.01E-02	3.12E-03	6.22E-03	0.00E+00	0.01	4.74E-04	3.30E-03	2.60E-05	-4.61E-06	1.32E-03		-7.11E-02
EP land	mol N equiv	3.07E-01	3.43E-02	6.80E-02	0.00E+00	0.07	5.16E-03	3.69E-02	2.85E-04	-4.73E-05	1.40E-02		-7.55E-01
POCP	kg NMVOC equiv	9.74E-02	1.18E-02	1.89E-02	0.00E+00	0.02	1.99E-03	1.02E-02	8.28E-05	-1.40E-05	7.71E-03		-4.15E-01
ADP minerals and metals	kg Sb equiv	8.89E-05	1.34E-05	1.49E-06	0.00E+00	0.00	2.91E-06	1.45E-04	1.81E-08	-6.21E-09	1.16E-06		-6.23E-05
ADP fossil fuels	MJ Hu	570.70	58.05	20.05	0.00	20.04	12.45	16.87	0.22	-0.11	15.51	-835.69	
WDP	m3 world equiv deprived	11.97	0.17	0.07	1.00	0.07	0.04	0.22	0.01	0.00	0.08	-4.39	
Legend	GWP = Global warming potential; luluc = Land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP = Abiotic depletion potential; WDP = Water deprivation potential (users)												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 60: Results of additional environmental impact indicators per metre [m] of 170/13 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PM	Disease incidence	6.39E-06	3.04E-07	3.77E-07	0.00E+00	3.77E-07	6.62E-08	1.95E-07	1.51E-09	-1.51E-10	1.03E-07		-5.53E-06
IRP	kBq U235 equiv	2.15E+00	2.98E-01	9.85E-02	0.00E+00	9.84E-02	6.41E-02	1.73E-01	9.86E-04	-4.93E-04	2.75E-02		-1.48E+00
ETP-fw	CTUe	781.97	45.29	13.78	0.00	13.78	9.77	61.91	0.14	-0.07	45.92		-2473.44
HTP-c	CTUh	4.94E-08	1.50E-09	1.13E-09	0.00E+00	1.13E-09	3.14E-10	2.09E-09	3.56E-12	-1.32E-12	8.20E-09		-4.42E-07
HTP-nc	CTUh	4.30E-07	4.54E-08	1.07E-08	0.00E+00	1.07E-08	9.87E-09	9.15E-08	9.23E-11	-3.68E-11	3.15E-08		-1.70E-06
SQP	Points	119.28	39.58	2.72	0.00	2.71	8.68	31.15	0.47	-9.61E-03	3.03	-163.20	
Legend	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems - freshwater; HTP-c = Potential toxicity comparison unit for humans - carcinogenic effect; HTP-nc = Potential toxicity comparison unit for humans - non-carcinogenic effect; SQP = Potential soil quality index												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 61: Results of parameters describing resource use per metre [m] of 170/13 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
PERE	MJ H _u	66.49	0.82	0.53	0.00	0.25	0.18	2.62	1.90E-03	-4.99E-03	0.32		-17.20
PERM	MJ H _u	0.28	0.00	-0.28	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PERT	MJ H _u	66.77	0.82	0.25	0.00	0.25	0.18	2.62	1.90E-03	-4.99E-03	0.32		-17.20
PENRE	MJ H _u	570.68	58.05	20.07	0.00	20.04	12.45	16.88	2.22E-01	-1.10E-01	15.52		-835.73
PENRM	MJ H _u	1.62E-02	0.00	-1.62E-02	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00		0.00
PENRT	MJ H _u	570.69	58.05	20.05	0.00	20.04	12.45	16.88	2.22E-01	-1.10E-01	15.52		-835.73
SM	kg	49.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.91		0.00
RSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
NRSF	MJ H _u	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
FW	m ³	4.70E-01	6.36E-03	2.34E-03	0.00E+00	2.33E-03	1.38E-03	8.59E-03	2.36E-04	-3.17E-05	2.64E-03		-1.42E-01
Legend	PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy resources as material utilisation; PERT = Total use of renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilisation; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of fresh water												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 62: Results of waste categories and output flows per metre [m] of 170/13 mm piling system

Results compliant with EN 15804												Additional information on the multi-recycling potential These values do not comply with the rules and specifications of EN 15804 (net flow rule)	Results non-compliant with EN 15804
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3		Multi-rec
HWD	kg	6.66E-04	7.21E-05	5.75E-05	0.00E+00	5.75E-05	1.57E-05	2.35E-05	1.62E-07	-4.01E-08	8.03E-05		-4.32E-03
NHWD	kg	4.18	1.43	0.06	0.00	0.06	0.32	0.25	0.73	0.00	0.02		-1.33
RWD	kg	2.01E-03	3.79E-04	2.61E-04	0.00E+00	2.61E-04	8.12E-05	9.35E-05	1.40E-06	-1.25E-07	1.55E-05		-8.35E-04
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
MFR	kg	0.00	0.00	0.00	0.00	0.00	0.00	48.91	0.00	0.00	0.00		0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
EEE	MJ	0.00E+00	0.00E+00	1.66E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
EET	MJ	0.00E+00	0.00E+00	1.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
Legend	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electric energy; EET = Exported thermal energy												

“Multi-rec” shows the multi-recycling potential without taking into account the net flow rule - Value non-compliant with EN 15804

Table 63: Results of description of biogenic carbon content at the gate per metre [m] of 170/13 mm piling system

Results compliant with EN 15804											
Parameter	Unit	A1 - A3	A4	A5	B1 - B7	C1	C2	C3	C4	D from A5	D from C3
C content product	kg C	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C content packaging	kg C	9.17E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Legend	C content product = biogenic carbon content in the product; C content packaging = biogenic carbon content in the associated packaging										

C content beech wood = 46.3%, beech wood packaging = 1.98E-02 kg/m

6 LCA: Interpretation

It should be noted that the impact assessment results are only relative statements that do not include any statements about “end-points” of the impact categories, exceeding of thresholds or risks.

Since the definitions of raw materials (the substances that remain in the product) and auxiliary substances (the substances that do not remain in the product) are not easily applicable in the production of the piles, as a certain percentage of the energy carrier coke or of the input material ferrosilicon or silicon carbide remains in the product, there is no splitting of A1-A3 in the interpretation or in the necessary dominance analysis.

In the dominance analyses of the entire life cycle of the investigated pile types, A1-A3 show up as the dominant modules for the majority of the investigated indicators. Therefore, the influence of the processes of modules A1-A3 is analysed in advance for the presentation of the life cycle dominance analyses (Figure 3). The influence of the individual processes in A1-A3 is identical for all pile types because the results are linear over the longitudinally related mass of the piles.

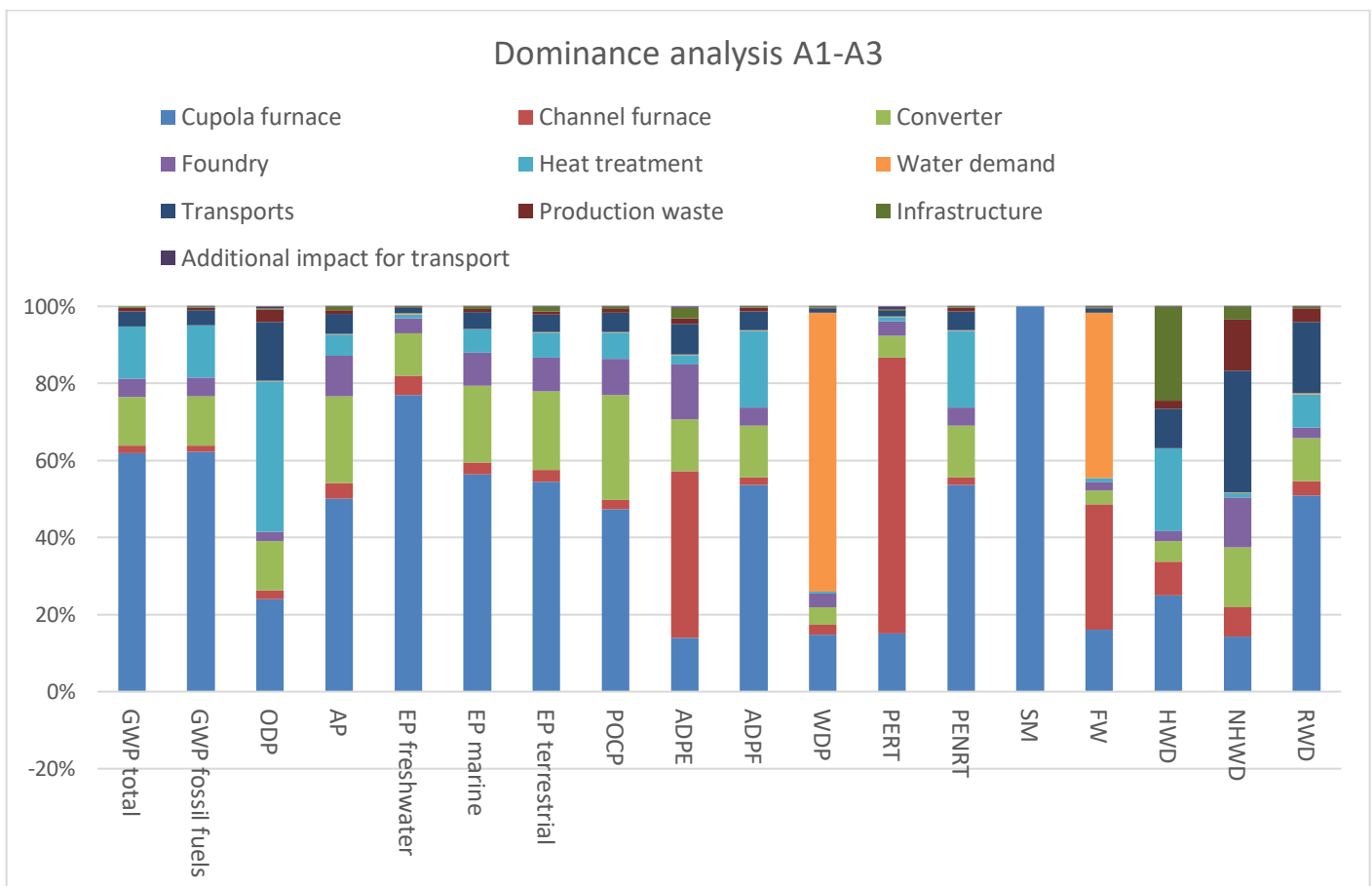


Figure 3: Dominance analysis A1-A3

Figure 3 shows that, for the majority of the indicators, the cupola furnace process has the greatest influence on the results. Here, combustion (GWP) and production (ODP, AP, EP freshwater, EP saltwater, POCP, ADP minerals and metals, ADP fossil fuels, PENRT) of foundry coke are the main driving factors.

The SiC pellets used in the cupola furnace (ODP, AP, ADP minerals and metals, WDP, PERT, FW, NHWD, RWD) also have a corresponding influence. Due to the modelling carried out or the estimation of their production, the influence of the SiC pellets is subject to corresponding fluctuation potential.

Figure 3 also shows that, as expected, the indicators WDP and FW are strongly influenced by water demand. The processes in the channel furnace have a strong influence on the indicators ADP minerals and metals, PERT and FW, which is due to the power required by the channel furnace.

During heat treatment in the annealing furnace, the pile types are run at different throughputs, which, depending on the pile type, results in energy expenditures for the respective heat treatment. A sensitivity analysis shows as extreme values for pile types 170 an ODP value for A1-A3 that is approx. 9% higher than for the given mean value and for pile types 98 an ODP value that is approx. 11.3% lower. The overall GWP result for pile types 170 is 3.3% higher and, for pile types 98, 4% lower than the result with the average heat treatment. The PENRT result for pile types 170 is 4.6% higher and, for pile types 98, 5.6% lower than the result with the average heat treatment. The results for all other indicators differ

by <1.8% from the results with the average heat treatment. The deviations in the results can be classified as small for the majority of the results. However, despite maximum deviations of $\pm 10\%$ (ODP), there has not been a split of heat treatment by pile type in order to avoid complexities because the throughput values given by the manufacturer for the pile types are average values and the actual throughputs (also for the individual pile types) fluctuate.

For the modelling of the life cycle inventory models, in some cases ecoinvent data sets were used whose data collection or reference year dates back more than 10 years (requirement EN 15804 or Bau EPD GmbH). Over the years, these data sets have been included in the various ecoinvent database versions, taking into account necessary adjustments for database updates. Nevertheless, these data sets are subject to corresponding potential for fluctuation because (technological) developments in recent years are, to some extent, not reflected in them.

A comparison of the results for A1-A3 per tonne of pile to the 2017 pile EPD results shows a -8.4% reduction for GWP total, a -4.9% reduction for ODP and a -12.3% reduction for ADP fossil fuels. Since in this EPD the C content in the SiC pellets was taken into account when determining the CO₂ emissions from the cupola furnace (and this did not happen when creating the EPD in 2017), the actual GWP reduction potential is, in reality, still higher by 45 kg CO₂ equiv per tonne of pile and results in a reduction of -12.3%. With regard to PENRT, a reduction of -16.2% was achieved compared to the EPD in 2017. All reductions are mainly due to the reduction of foundry coke used in the cupola furnace. For PERT, there is an overall increase of 26.1% compared to 2017, which is due to the inclusion of the TIWAG electricity supplied and the share of renewable energies contained in this. For other indicators, a comparison was not possible due to the design according to EN 15804+A1 (EPD in 2017) or EN 15804+A2 (EPD in 2022) and the differences in the calculation methods regarding the indicators to be used.

Taking into account the TIWAG electricity mix in A1-A3 gives a reduction of -5.9% for GWP total compared to the use of the average Austrian electricity mix, which is mainly due to the reduction of the GWP fossil share. The maximum reduction is achieved for EP freshwater with -17.1%. The result for PENRT is reduced by -7.1% and the result for PERT is increased by 32.27%.

Figure 4 to Figure 12 show for the respective pile type the percentage share of the modules A1-A3 production, A4 transport to the building site, A5 installation, C1 removal, C2 transport for waste treatment or disposal, C3 waste treatment and C4 waste disposal in the (most important) parameters considered. The production of piles (A1-A3) is the main contributor for all impact categories (except ADP minerals and metals). The great influence of the product stage is, as already mentioned, mainly due to the processes in the cupola furnace or the foundry coke. The influence of production increases minimally with increasing wall thickness or diameter. The transport of the piles to the building site and the installation and removal of the piles can be identified as the next most influential processes (again with the exception of ADP minerals and metals). For the parameter ADP minerals and metals, recycling in C3, and here in particular the infrastructure of the recycling plant, represents the main load. For the parameter NHWD (non-hazardous waste disposed), waste disposal C4 has a corresponding influence.

Compared to the previous EPD for the TRM piles, corresponding reductions can be seen mainly with regard to production (see analysis of A1-A3), which is mainly due to the optimisation of the foundry coke used. A comparison of the life cycle results is not made here because in the EPD in 2017 the modules C1-C4 were used without loads as these were taken into account with the scenario "remain in the ground". In the meantime, this approach can no longer be classified as representative.

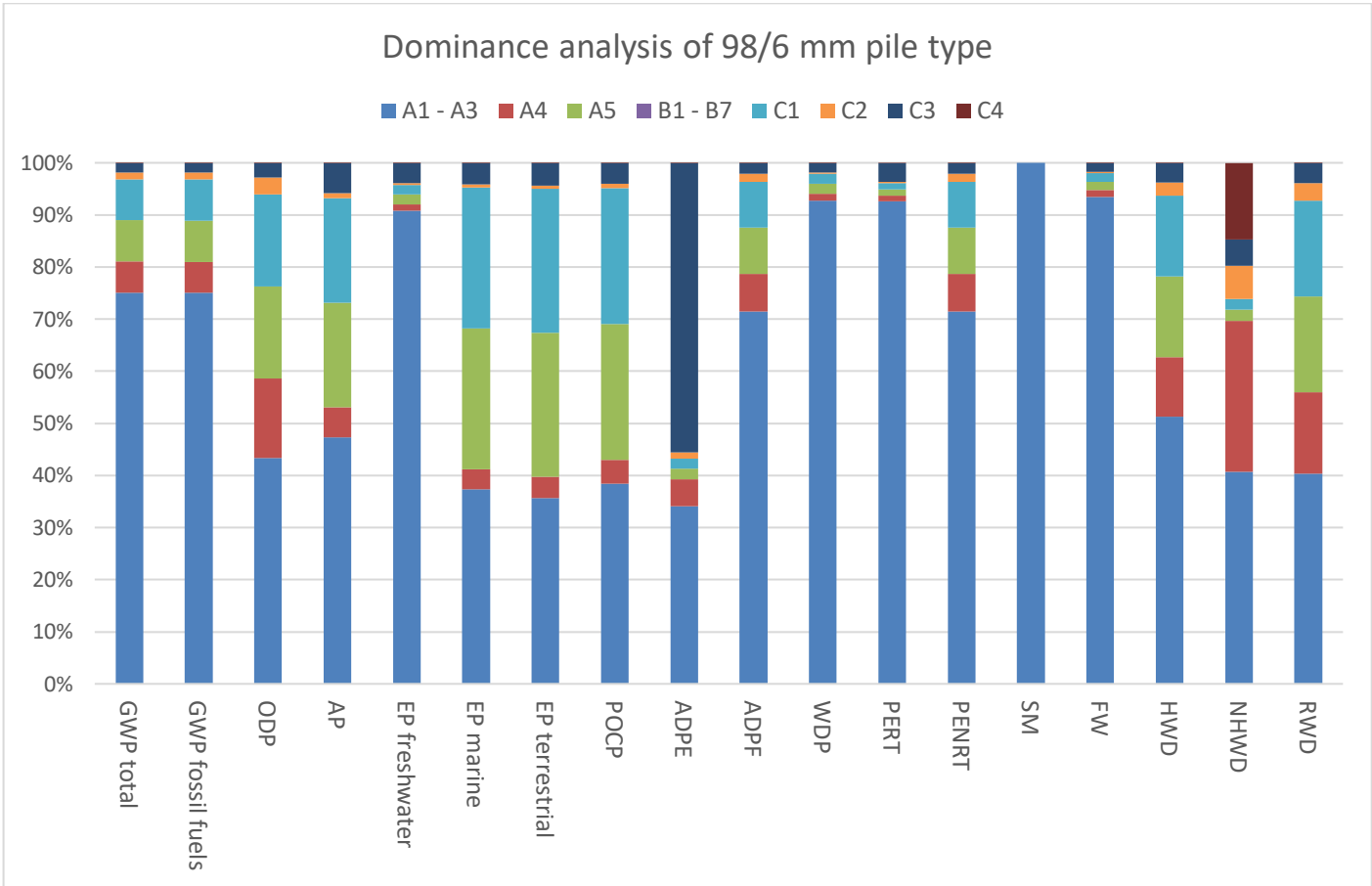


Figure 4: Dominance analysis of 98/6 mm pile type

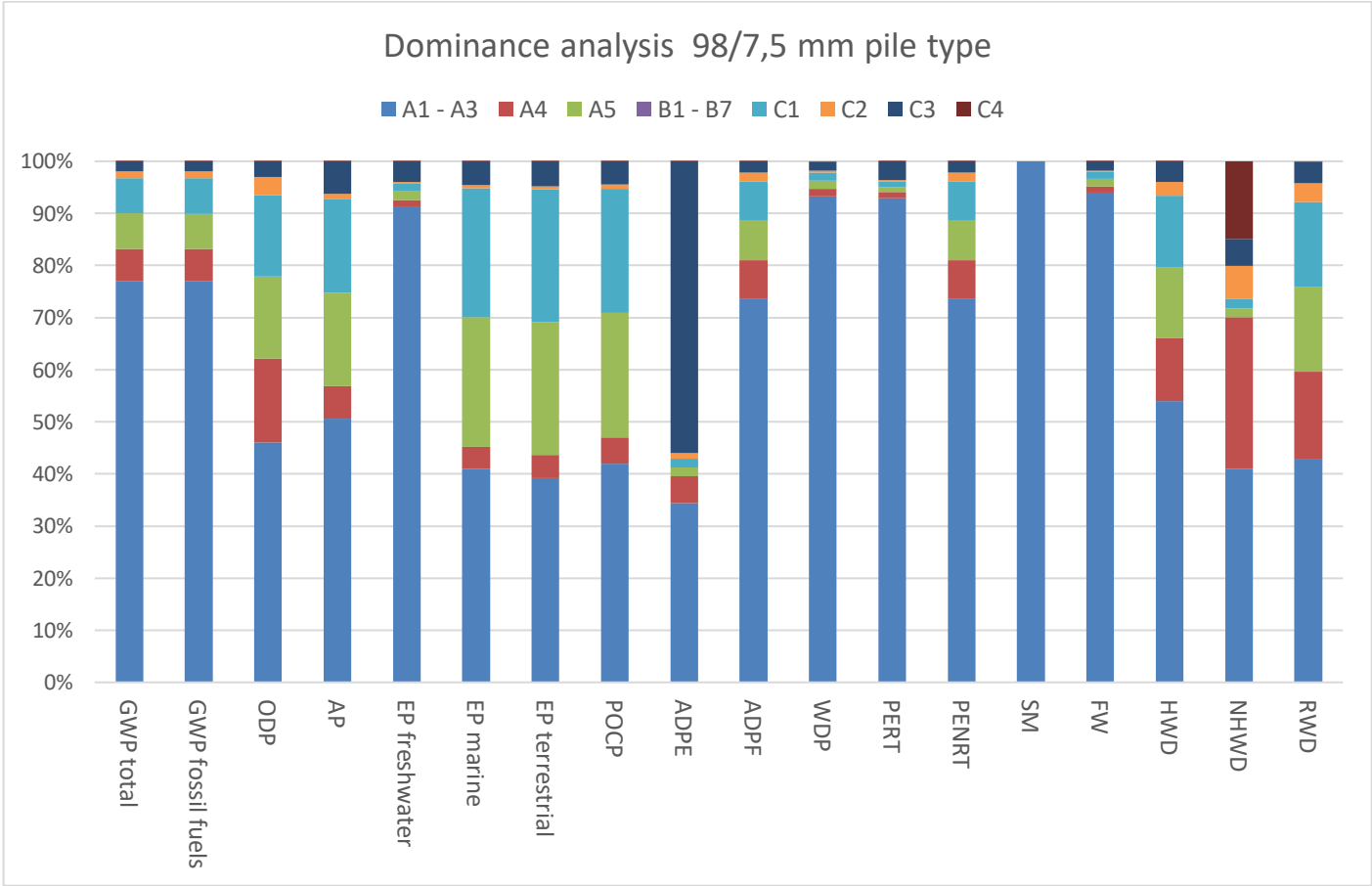


Figure 5: Dominance analysis of 98/7.5 mm pile type

Dominance analysis 118/7,5 mm pile type

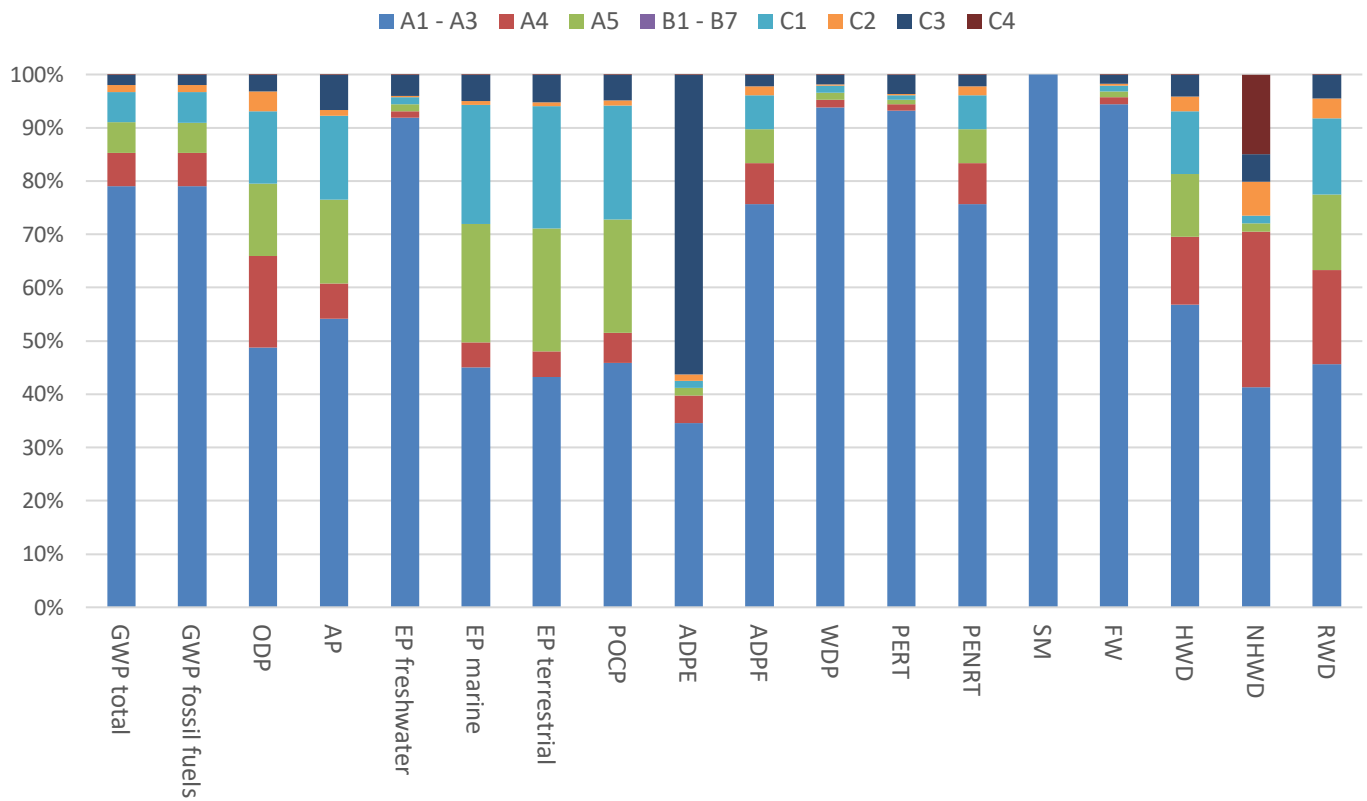


Figure 6: Dominance analysis of 118/7.5 mm pile type

Dominance analysis 118/9 mm pile type



Figure 7: Dominance analysis of 118/9 mm pile type

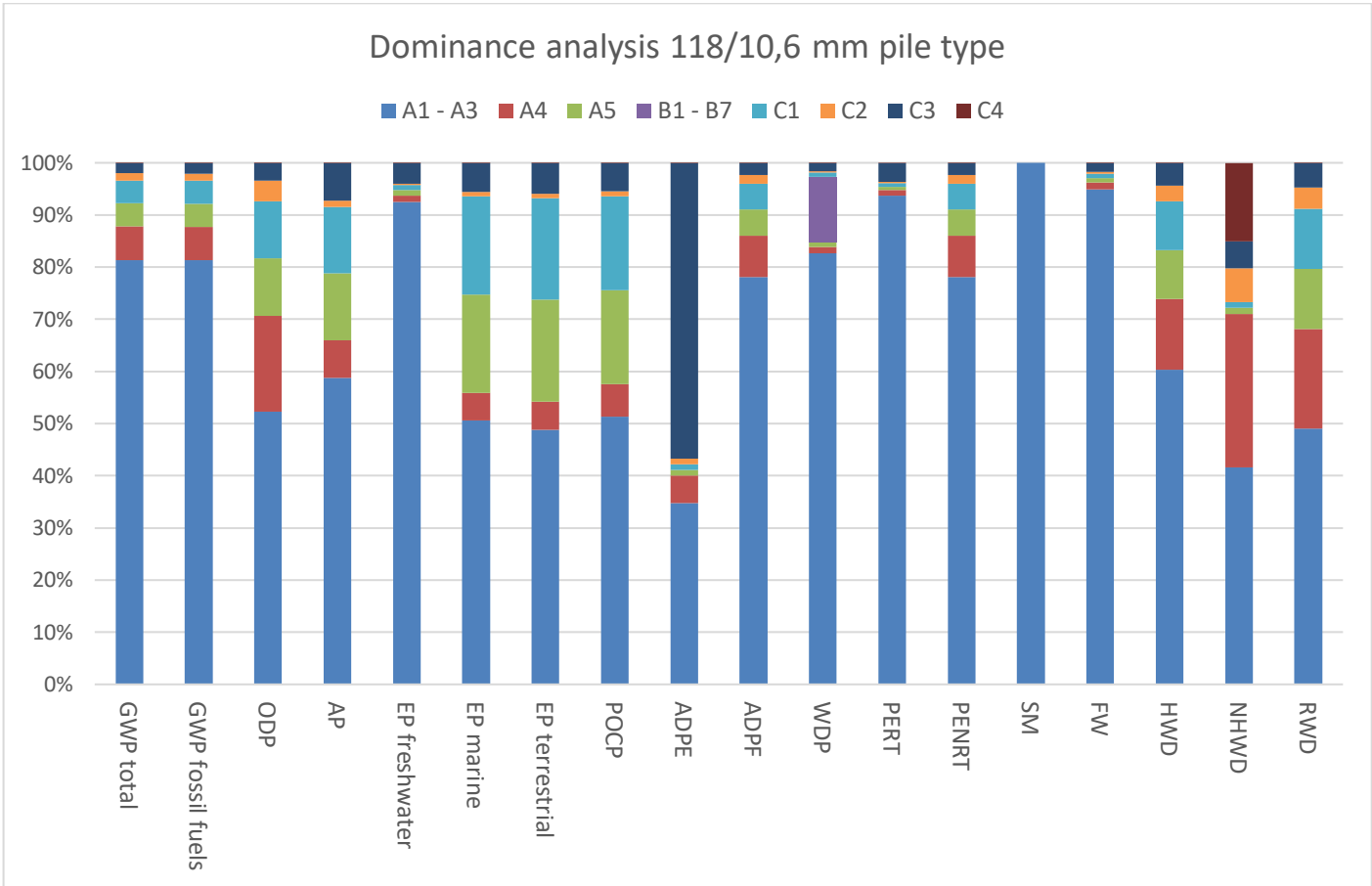


Figure 8: Dominance analysis of 118/10.6 mm pile type

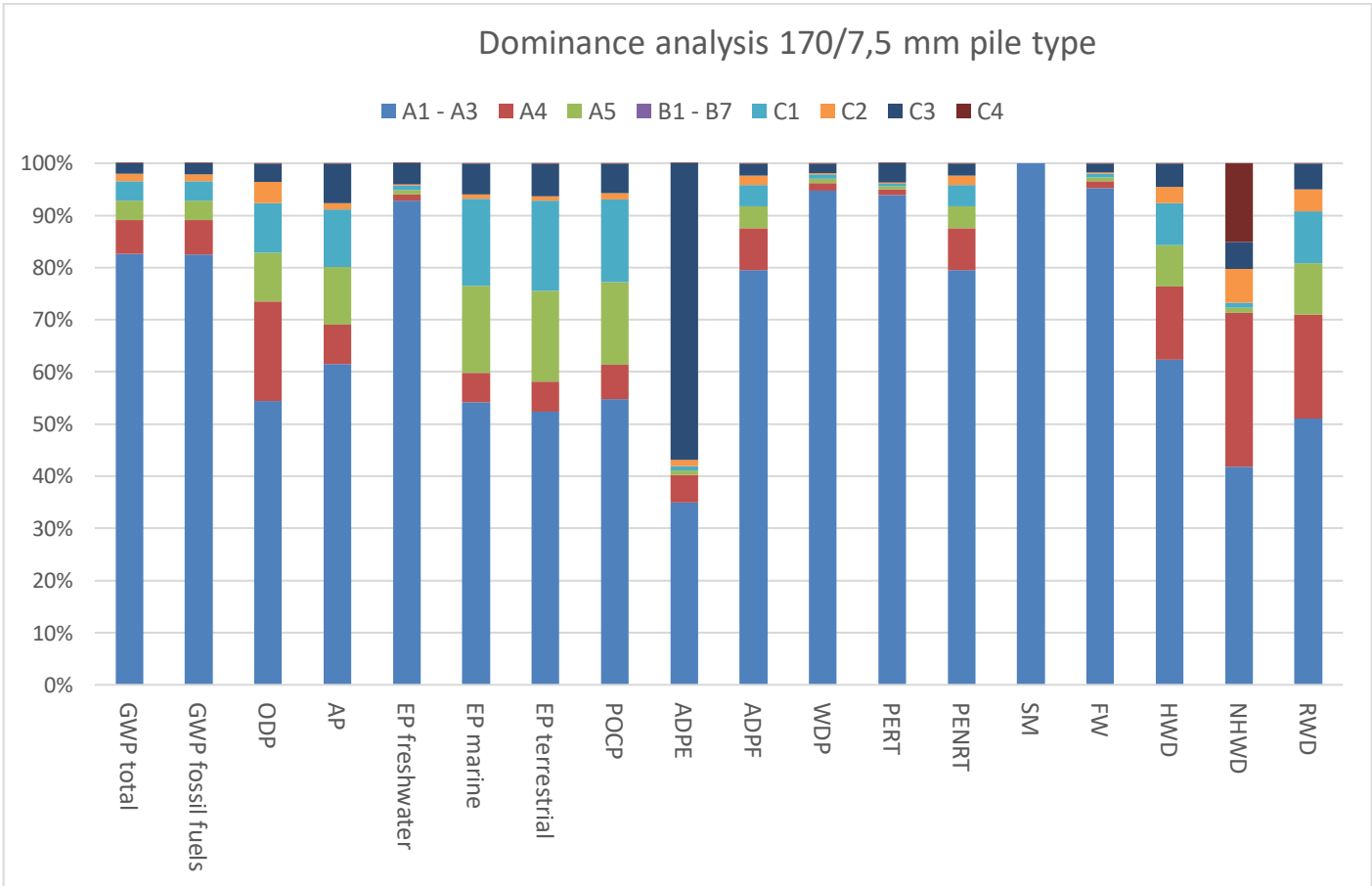


Figure 9: Dominance analysis of 170/7.5 mm pile type

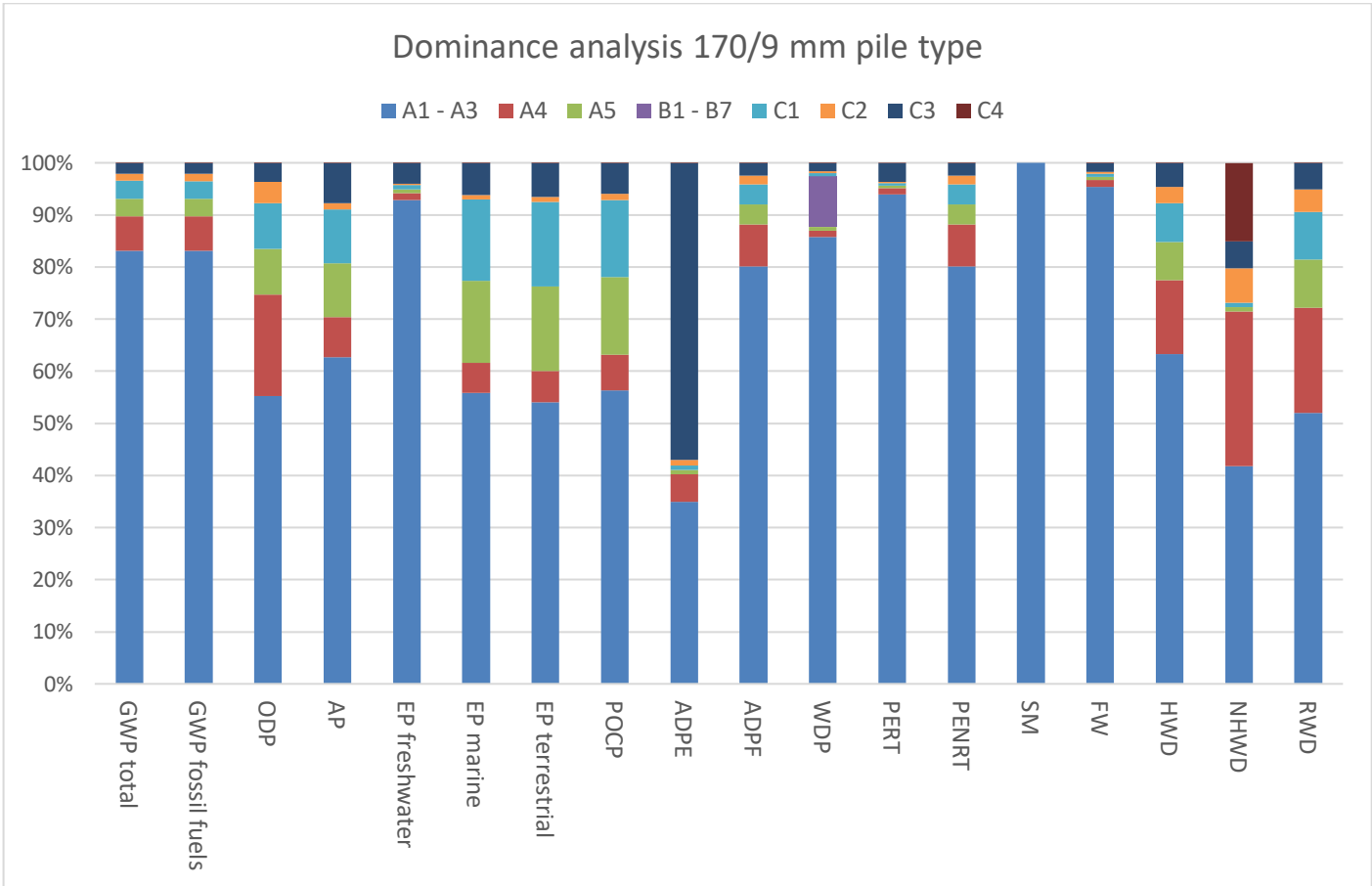


Figure 10: Dominance analysis of 170/9 mm pile type

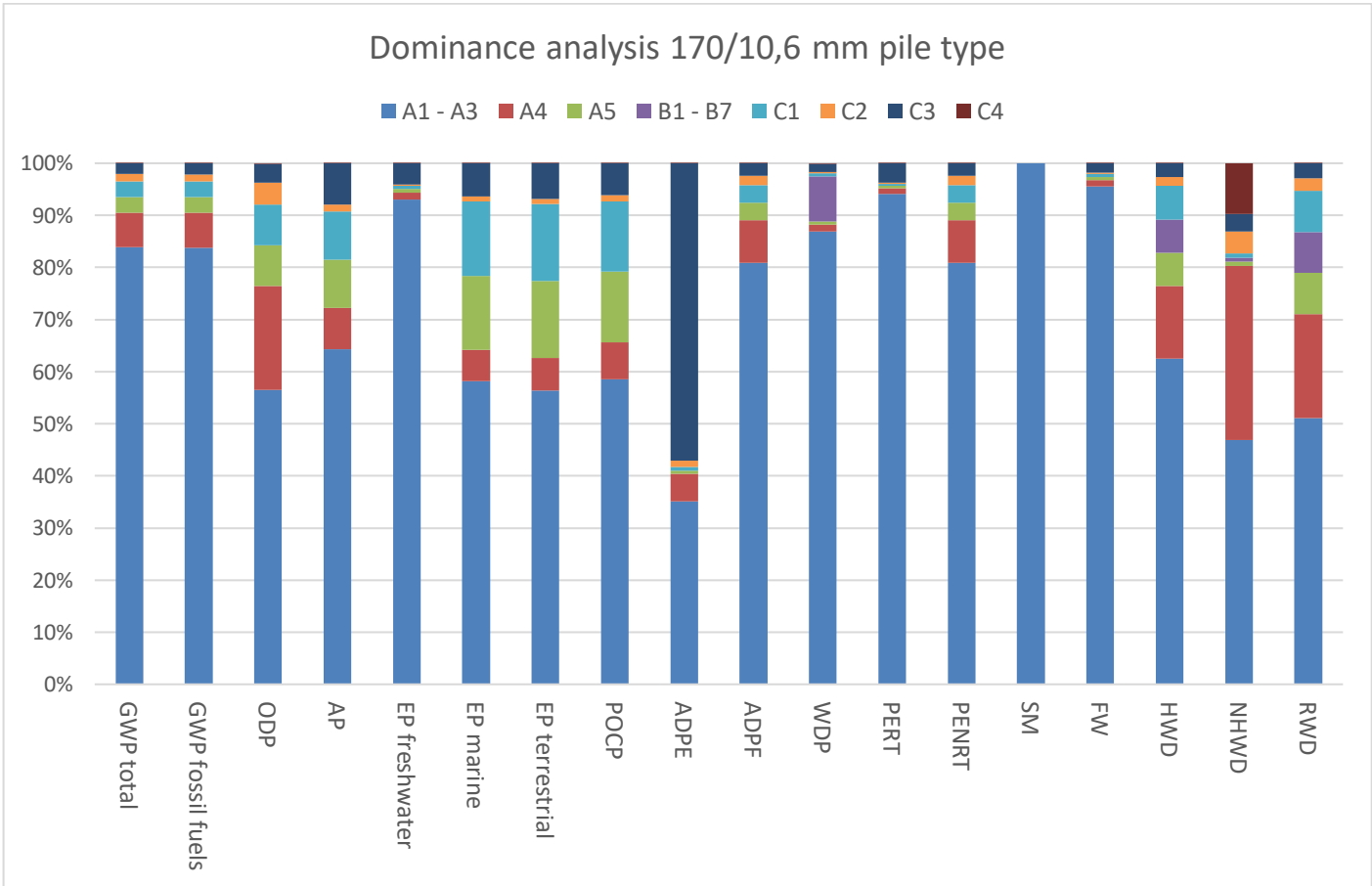


Figure 11: Dominance analysis of 170/10.6 mm pile type

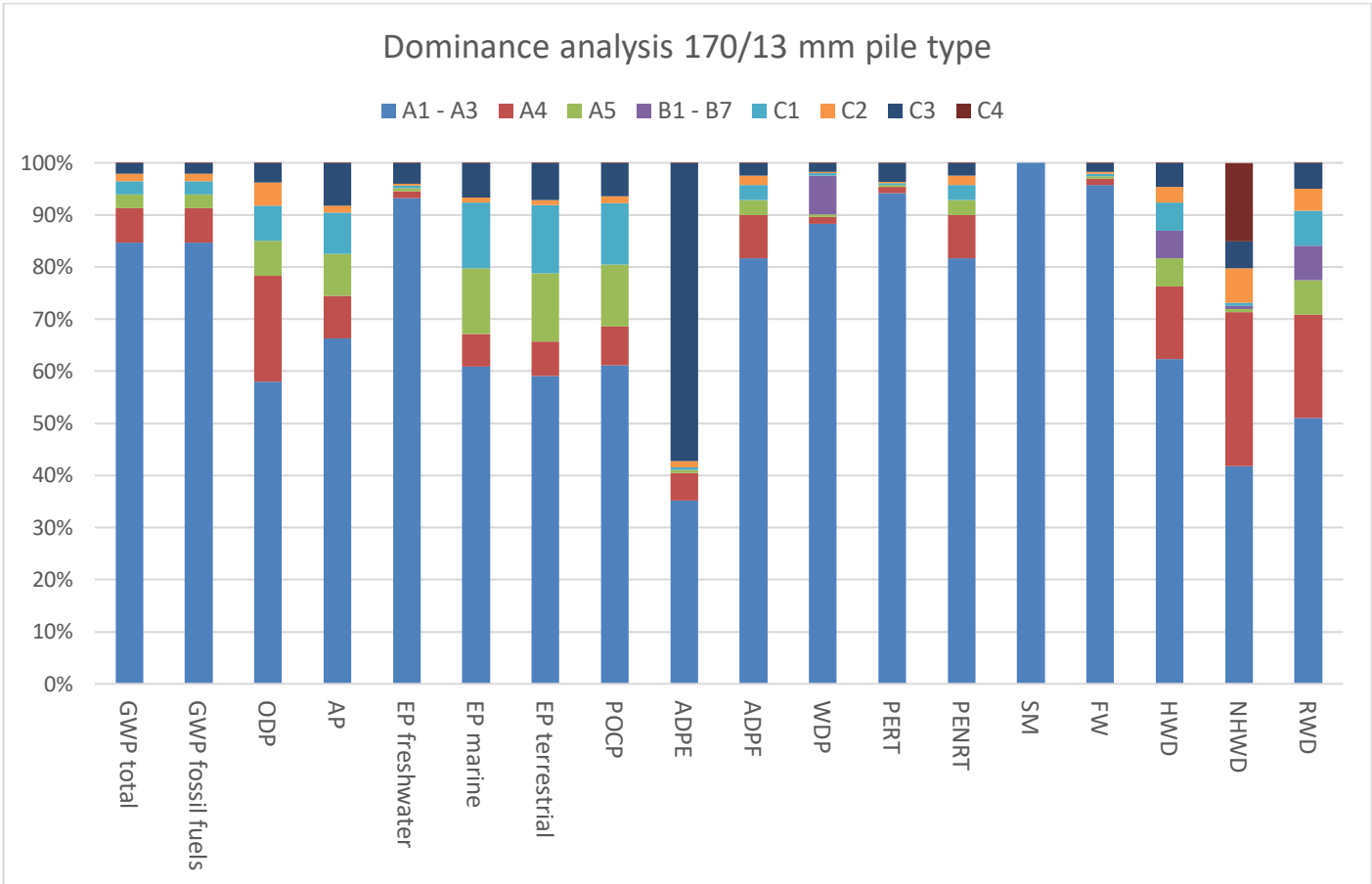


Figure 12: Dominance analysis of 170/13 mm pile type

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8.3 Abbreviations

EPD	Environmental product declaration
PCR	Product category rules
LCA	Life cycle assessment
LCI	Life cycle inventory analysis
LCIA	Life cycle impact assessment
RSL	Reference service life
ESL	Estimated service life
EPBD	Energy Performance of Buildings Directive
GWP	Global warming potential
ODP	Depletion potential of the stratospheric ozone layer
AP	Acidification potential of soil and water
EP	Eutrophication potential
POCP	Formation potential of tropospheric ozone
ADP	Abiotic depletion potential

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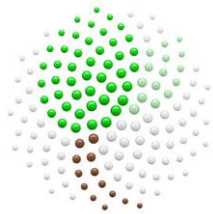
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