ENVIRONMENTAL PRODUCT DECLARATION

HEMP AND LIME BIOCOMPOSITE BUILDING PRODUCTS

BLOCCO AMBIENTE

BIO BETON **PRONTO**

BIO BETON **200** JET

PROGRAM OPERATOR	EPDItaly
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TECNO CANAPA BIOEDILIZIA

SENINI

SENINI - Via Erculiani 192 - 25018 Novagli di Montichiari (BS) IT | Conforme a ISO 14025 e EN 15804:2012+A2:2019

» GENERAL INFORMATION

PRODUCT NAME	PRODUCT NAME Blocco Ambiente®, Bio Beton® Pronto, Bio Beton® Jet
EPD OWNER	Senini S.r.l.
COMPANY ADDRESS	Via Erculiani, 192 - Montichiari BS - Italia
PRODUCTION SITE ADDRESS	Via Erculiani, 192 - Montichiari BS - Italia
COMPANY CONTACT	Paolo Ronchetti - tecnocanapa@senini.it
CPC CODE	37520 Boards, blocks and similar articles of vegetable fibre, straw or wood waste agglomerated with mineral binders
TYPE OF EPD	From cradle to gate with options, modules C1–C4, and module D (additional modules: A4-A5, B1)
APPLIED STANDARDS	ISO 14040:2006 ENVIRONMENTAL MANAGEMENT - LIFE CYCLE ASSESSMENT - PRINCIPLES AND FRAMEWORK; 2006; ISO 14044:2006+A1:2018 Environmental management - Life cycle assessment - Requirements and guidelines; 2006; EN ISO 14025:2010 Environmental labels and declarations - Type III environmental declarations - Principles and procedures; 2010;
REFERENCE PCR	PCR ICMQ-001/15 rev. 3 of 02/12/2019 The EN 15804/2019 standard constitutes the framework reference for the PCR.
REFERENCE DOCUMENTS	EPD Italy REGULATION OF THE EPDItaly PROGRAM - Revision 5.2 (16/02/2022) - www.epditaly.it
PROGRAM OPERATOR	EPDItaly (www.epditaly.it) Via G. De Castillia, 10 - 20124 Milan, Italy
TECHNICAL SUPPORT	Materials for Energy and Environment Lab Department of Chemistry, Materials and Chemical Engineering “Giulio Natta” Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milano, Italy
COMPARABILITY	EPDs related to the same product category but belonging to different programs may not be comparable. In particular, EPDs of construction products may not be comparable if they do not comply with EN 15804 standard.
RESPONSIBILITY	Senini declines EPDItaly from any non-compliance with the environmental legislation self-declared by the manufacturer. The holder of the declaration will be responsible for the information and supporting evidence; EPDItaly declines all responsibility for the information, data and results of the product life cycle assessment by the manufacturer.

INDEPENDENT VERIFICATION OF THE EPD AND THE DATA CONTAINED IN IT CONDUCTED IN ACCORDANCE WITH ISO 14025 STANDARD		
INTERNAL	✓	EXTERNAL
Third party verification		ICMQ, via G. De Castillia, 10 - 20124 Milano, Italy. Accredited by ACCREDIA

» COMPANY

SENINI S.R.L.

SENINI was founded in 1960 as a manufacturer of masonry blocks which soon integrated with the production of self-locking flooring and curbs, becoming over the years an undisputed leader in the sector. Despite the evolution and transformation over time into an important industrial group, SENINI maintains its imprint as a family business where the business is lived as an integral part of the family unit and of life, where the search for quality and "beauty" have also become the convinced attention towards the environment.

During these 56 years of activity, SENINI has continuously invested and developed its production site which today has 5 state-of-the-art plants, becoming the first production centre in Italy. The last plant (chronologically as it was completed in 2009) is, to date, the only one in the world entirely prepared for the production of photocatalytic flooring that reduces polluting fine dust.

Research, innovation, sensitivity to new trends and needs of the end user have led SENINI to always develop new products, shapes and colours. The latest product from this mission is the TECNOCANAPA line, which includes the BLOCCO AMBIENTE® and BIO BETON® products composed entirely of natural elements, ideal for dividing walls or coating, providing high thermal insulation and thermal mass performances, providing natural moisture regulation and breathability for a more comfortable and healthier home.

THE FACTORY

On an area of approximately 100,000 square meters, of which 15,000 are covered, it includes five plants for the production of floors, blocks and curbs, assisted by 4 subsequent processing units (tumbling, antique staining, shot peening, splitting) for the artefacts of greater value. Two other plants are dedicated to the production of special pieces and complementary elements. The entire production uses: an aggregate crushing and selection plant (which guarantees the quality and consistency of the main raw material used); a well-equipped internal laboratory that verifies, for each production batch, compliance with the requirements of ISO 9001, UNI EN 1338, 1339, 1340, 771-3 standards.

QUALITY AND ENVIRONMENT

Product quality and attention to the environment are primary and indispensable factors for SENINI. The certifications, through careful checks carried out by an accredited body, guarantee that the company operates with a view to sustainability and that its products really aim at customer satisfaction. Hence the choice of a certification that guarantees total compliance with these values relating to:

- the quality of production processes (ISO 9001);
- the quality of the products (UNI EN 1338, 1339);
- respect for the environment (ISO 14001) of all the Company's activities.

» DESCRIPTION OF THE PRODUCTS

SUBJECT OF STUDY

The subject of study of this report are three hemp and lime green building products: Blocco Ambiente®, Bio Beton® Pronto and Bio Beton® Jet. The three products are part of the Tecnocanapa® production line (https://tecnocanapa-bioedilizia.it/) of the company Senini s.r.l. (https://www.senini.it/). The products considered combine properties of thermal inertia and thermal, acoustic and hygrometric insulation.

Blocco Ambiente® is a 20×50 cm prefabricated block, available in thicknesses of 8, 12, 20, 25, 30, 36, 40 cm. This study focuses on the 20x50x30 cm block. Its main applications are:

- construction of insulating and transpiring masonry walls;
- external insulating counterpart on existing masonry;
- internal insulating counterpart on existing masonry;
- sub-floor insulation;
- internal partitions with acoustic insulation.

Bio Beton® Pronto and Bio Beton® Jet are solid insulating materials. They are mainly applied in:

- insulation of floors, roofs and attics;
- construction of insulating and transpiring masonry walls;
- existing external masonry insulation;
- existing internal masonry insulation;
- sub-floor insulation.

Bio Beton® Pronto is delivered to the construction site already mixed and ready for use in big bags, the product is spread by casting on the roof, floor screeds, attic, sub-floor or in formwork. Bio Beton® 200 Jet, on the other hand, is mixed and spread directly on site using the Tecnocanapa Hempjet projection machine.

The products being studied are classified under item 37520 “Boards, blocks and similar articles of vegetable fibre, straw or wood waste agglomerated with mineral binders”. For products belonging to this class, PCR ICMQ-001/15 rev.3 is applicable.

» TECHNICAL CHARACTERISTICS OF THE PRODUCTS

TABLE 1 TECHNICAL FEATURES OF BLOCCO AMBIENTE, THICKNESS 30 CM

MEASURES: LENGTH THICKNESS HEIGHT [CM]	DENSITY [KG/M3 DRY]	THERMAL CONDUCTIVITY [W/MK]	THERMAL TRANSMITTANCE [W/M2K]	SPECIFIC HEAT CAPACITY [J/KGK]	VAPOUR PERMEABILITY [μ]	SOUND ABSORPTION COEFFICIENT [AW]	COMPRESSIVE STRENGTH [KPA]	SHEAR TRACTION WITH RAWPLUG [KN]	ORTHOGONAL TRACTION WITH RAWPLUG [KN]	REACTION TO FIRE
50x30x20	330	0.07	0.22	1280	4.5	1 – CLASSE A	0.4	2.067	2.734	B – s1, d0

TABLE 2 TECHNICAL CHARACTERISTICS OF BIO BETON READY, THICKNESS 30 CM

THICKNESS [CM]	DENSITY [KG/M3 DRY]	THERMAL CONDUCTIVITY [W/MK]	THERMAL TRANSMITTANCE [W/M2K]	SPECIFIC HEAT CAPACITY [J/KGK]	VAPOUR PERMEABILITY [μ]	SOUNDPROOFING INDEX LAID THK. 20 CM ON WOODEN FLOOR (RW) – DB 40‘	COMPRESSION BEHAVIOUR (TENSION AT 10%) [KPA]	RESISTANCE TO EXTERNAL FIRE OF THE COVERINGS
30	190	0.053	0.17	1480	4.5	56	71	Broof(t2)

TABLE 3 TECHNICAL CHARACTERISTICS OF BIO BETON JET, THICKNESS 30 CM

THICKNESS [CM]	DENSITY [KG/M3 DRY]	THERMAL CONDUCTIVITY [W/MK]	THERMAL TRANSMITTANCE [W/M2K]	SPECIFIC HEAT CAPACITY [J/KGK]	VAPOUR PERMEABILITY [μ]	SOUNDPROOFING INDEX SPRAYED THK. 28 CM ON BRICK THK. 12 CM INCLUDING INTERNAL/EXTERNAL PLASTER (RW) [DB]	REACTION TO FIRE WITH GYPSUM-FIBRE PANELS
30	230	0.053	0.17	1480	4.5	56	A1 En 13501-1 Class I

DECLARED UNIT

This study is based on a declared unit. The same declared unit was considered, equal to 1 m2 of wall with a thickness of 30 cm, for all three products analysed. In the case of the Blocco Ambiente®, this corresponds to ten 50x20x30 cm bricks. In the case of Bio Beton® Pronto and Bio Beton® Jet, this corresponds to 0.30 m3 of product.

COMPOSITION OF THE PRODUCTS

Blocco Ambiente®, Bio Beton® Pronto and Bio Beton® Jet are prepared with the same ingredients, mixed in different quantities determined by the characteristics required of the mixture in the three cases. The ingredients are dolomitic lime, hemp shiv, microorganisms (probiotic additives) and water. The recipes of the three products, referring to a declared unit, are shown in Table 4..

TABLE 4 RECIPES OF THE PRODUCTS BEING STUDIED (BLOCCO AMBIENTE, BIO BETON READY, BIO BETON JET) REFERRED TO A UD

INGREDIENT	BLOCCO AMBIENTE		BIO BETON PRONTO		BIO BETON JET	
	% mass	kg/UD	% mass	kg/UD	% mass	kg/UD
Dolomitic binder	35%	66.00	20%	24.00	28%	36.00
Hemp shiv	18%	33.00	28%	33.00	25%	33.00
Microorganisms	1%	1.20[a]	1%	0.60	<1%	0.60
Water	46%	87.00[a]	51%	60.00	46%	60.00
Tot wet product	-	187.20	-	117.60	-	129.60
Tot dry product	-	99.00	-	57.00	-	69.00

[a] The water and microorganisms content in the Blocco Ambiente® refers to the wet product, before the maturation phase (during which it loses about 90% of humidity).

ALL PRODUCTS INCLUDED IN THIS EPD DO NOT CONTAIN NOR RELEASE DANGEROUS SUBSTANCES (REGULATIONS (EU) 1907/2006 (REACH) AND (EU) 272/2008)

PACKAGING OF PRODUCTS

The products leaving the Senini S.r.l. of Montichiari are packaged to be transported to the construction site. The blocks are loaded on wooden pallets, wrapped in a polyethylene film and secured with polypropylene straps. Bio Beton® Pronto is packaged in polyethylene raffia bags (big bag). Bio Beton® Jet is mixed directly on site, so at the Montichiari production plant the hemp shiv and lime are packaged separately in paper bags which are then loaded onto wooden pallets.

TABLE 5 COMPOSITION OF THE PACKAGING OF PRODUCTS LEAVING THE PRODUCTION PLANT, QUANTITIES REFERRING TO ONE UD.

BLOCCO AMBIENTE			BIO BETON PRONTO			BIO BETON JET		
Component	**Material**	**Quantity [kg/UD]**	**Component**	**Material**	**Quantity [kg/UD]**	**Component**	**Material**	**Quantity [kg/UD]**
Strap	Polypropylene	0.06				Lime bags	Paper	0.23
Film	Polyethylene	0.09	Big bags	Polyethylene	0.35	Hemp shiv bags	Paper	0.33
Pallet	Wood	1.68				Pallet	Wood	0.59

CONTENT OF BIOGENIC CARBON

TABLE 6 CONTENTS OF BIOGENIC CARBON AT THE EXIT FROM THE FACTORY GATES FOR UD OF BLOCCO AMBIENTE, BIO BETON PRONTO AND BIO BETON JET

Content of biogenic carbon	Blocco Ambiente	Bio Beton Pronto	Bio Beton Jet
Content of biogenic carbon in the products [kg C/UD]	16.50	16.50	16.50
Content of biogenic carbon in the packaging [kg C/UD]	1.49	0.00	0.65
Note: 1 kg of biogenic carbon corresponds to 44/12 kg of CO_2			

» PRODUCTION PROCESS

BLOCCO AMBIENTE

The production of Blocco Ambiente® is carried out with a cold process at the production plant of Senini s.r.l. in Montichiari (Brescia) and includes the phases of mixing, pressing, handling, maturing and packaging. The maturing phase is necessary for the material to develop adequate mechanical strength for installation, the minimum period required is 40 days but, given the organization of production through the creation of a warehouse, the product is brought to the construction site after a period of 3-6 months of maturing. During the block maturing phase, the carbonatation process starts, which consists in the reaction of the calcium hydroxide contained in the lime with the carbon dioxide present in the atmosphere with consequent formation of calcium carbonate, this phenomenon involves the withdrawal of CO2 from the atmosphere and the consequent storage of carbon in the material in the form of calcium carbonate. In order to be transported to the construction site, the blocks are loaded on wooden pallets, wrapped in a polyethylene film and secured with polypropylene straps.

BIO BETON PRONTO

As for Bio Beton® Pronto, the ingredients are mixed at the company's plant in Montichiari, and the semi-wet material obtained is placed in 2m3 big bags and transported to the construction site for installation.

BIO BETON JET

The Bio Beton® Jet is cold produced on site, the binder and hemp shiv leave the company in bags which, once on site, are used to power a machine that supplies the water needed during installation and is composed of two parts: a plastering machine and a sprayer.

» APPLICATION FIELD AND TYPE OF EPD

This LCA study analyses the life cycle of biocomposite hemp and lime construction products “from cradle to gate with options, modules C1–C4, and module D”. The chosen approach requires to necessarily include the production and supply of raw materials (A1), the transport of raw materials to the Senini production site (A2), the production process of the products (A3), the demolition at the end of life (C1), the transport of the final waste to the treatment site (C2), the final treatments (C3), the disposal of residual waste (C4). Furthermore, the study also evaluates the presence of any benefits beyond the system boundaries (D). In addition, modules A4 (transport to the construction site) and A5 (installation) of the Construction phase and module B1 (use) of the Use phase were considered. On the other hand, modules B2-B7 of the Use phase are excluded from the system boundaries.

Production phase			Construction phase		Use phase							End of life phase				After end of life
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw materials production	Transport to the production site	Product manufacture	Transport to the construction site	Installation	Use	Maintenance	Repairing	Replacing	Renovation	Energy consumption during use	Water consumption during use	Decommissioning and demolition	Demolition waste transport	Demolition waste treatment	Demolition waste disposal	Potential for recycling, recovery, reuse beyond the system boundaries
√	√	√	√	√	√	MND	MND	MND	MND	MND	MND	√	√	√	√	√
MND = Module Not Declared																

Tipo di EPD: Specification, only for the products listed in the previous pages of this declaration | **Database:** ecoinvent 3.8, Agri-footprint 5.0 | **Software:** Simapro 9.2

» PROCESSES WITHIN THE SYSTEM BOUNDARIES

PRODUCTION PHASE - MODULE A1

The impacts associated with the raw materials included in the recipe were considered within module A1:

- cultivation of hemp and scutching process to obtain hemp shiv;
- production of dolomitic lime;
- production of microorganisms.

PRODUCTION PHASE - MODULE A2

The transport of raw materials (hemp shiv, lime, microorganisms) from the supplier's plant to the Senini production site was considered in module A2.

PRODUCTION PHASE - MODULE A3

The following was considered in module A3:

- consumption of water and energy within the plant;
- production of packaging;
- emissions due to the production process;
- absorption of CO2 due to the carbonatation of Blocco Ambiente® during the maturing phase.

CONSTRUCTION PHASE - MODULE A4

Module A4 includes transport from the production site to the product installation site and related primary and secondary packaging. In the case of Bio Beton® Jet, the transport of the machine necessary for the application of the product is also considered.

CONSTRUCTION PHASE - MODULE A5

The following was considered in module A5:

- disposal of the packaging used to transport the three products to the construction site;
- electricity consumption for installation (only for Bio Beton® Jet)
- water consumption for installation (only for Bio Beton® Jet).

» PROCESSES WITHIN THE SYSTEM BOUNDARIES

USE PHASE - MODULE B1

The withdrawal of CO2 from the atmosphere due to the carbonatation process that occurs during the service life of the products was considered in module B1.

END OF LIFE PHASE - MODULE C1

Module C1 regards the process of demolition and deconstruction of the products at end of life.

END OF LIFE PHASE - MODULE C2

The transport of demolition waste to disposal plants was considered in module C2.

END OF LIFE PHASE - MODULE C3

Since materials sent for recycling or recovery were not considered, no processes were considered in module C3.

END OF LIFE PHASE - MODULE C4

Landfill disposal of products as inert materials is considered in module C4.
In this module, the withdrawal of CO2 from the atmosphere due to the completion of the carbonatation process of the material placed in landfill was counted.

END OF LIFE PHASE - MODULE D

The study conducted on the entire life cycle of the blocks shows that there is no phase to which benefits beyond the system boundaries can be associated (D).

» LCA RESULTS

TABLE 7 ENVIRONMENTAL IMPACT INDICATORS PER UD OF BLOCCO AMBIENTE

Indicator	Unit of measurement	Production phase			Distribution phase		Use phase	End of life phase				Beyond the system boundaries	Total
		A1	A2	A3	A4	A5	B1	C1	C2	C3	C4	D	
GWP-total	kg CO_2 eq.	3.51E+00	6.13E+00	-1.56+00	2.27E+00	5.66E+00	-2.22E+01	3.72E-01	7.11E-01	0.00E+00	-8.17E+00	0.00E+00	-1.33E+01
GWP-fossil	kg CO_2 eq.	6.70E+01	6.13E+00	-1.33E+00	2.27E+00	2.10E-01	-2.22E+01	3.72E-01	7.11E-01	0.00E+00	-8.17E+00	0.00E+00	4.50E+01
GWP-biogenic	kg CO_2 eq.	-6.35E+01	1.93E-03	-2.45E+00	7.23E-04	5.45E+00	-1.03E-04	1.06E-04	2.23E-04	0.00E+00	3.08E-04	0.00E+00	-5.83E+01
GWP-luluc	kg CO_2 eq.	1.72E-02	4.90E-05	4.41E-03	1.84E-05	1.02E-06	0.00E+00	9.18E-06	5.66E-06	0.00E+00	8.51E-06	0.00E+00	2.17E-02
ODP	kg CFC11 eq.	4.49E-06	1.44E-06	1.95E-07	5.39E-07	6.54E-09	0.00E+00	8.33E-08	1.66E-07	0.00E+00	5.19E-08	0.00E+00	6.98E-06
AP	mol H^+ eq.	1.66E-01	2.06E-02	8.01E-03	7.90E-03	2.81E-04	0.00E+00	4.01E-03	2.39E-03	0.00E+00	2.57E-03	0.00E+00	2.12E-01
EP-freshwater	kg P eq.	1.27E-02	2.48E-05	4.53E-04	9.28E-06	3.04E-06	0.00E+00	2.23E-06	2.86E-06	0.00E+00	7.42E-06	0.00E+00	1.32E-02
EP-marine	kg N eq.	9.96E-02	6.49E-03	1.61E-03	2.53E-03	1.69E-04	0.00E+00	1.80E-03	7.57E-04	0.00E+00	1.12E-03	0.00E+00	1.14E-01
EP-terrestrial	mol N eq.	4.25E-01	7.14E-02	1.71E-02	2.78E-02	1.37E-03	0.00E+00	1.97E-02	8.31E-03	0.00E+00	1.23E-02	0.00E+00	5.83E-01
POCP	kg NMVOC eq.	7.34E-02	1.95E-02	6.15E-03	7.58E-03	3.61E-04	0.00E+00	5.40E-03	2.27E-03	0.00E+00	3.42E-03	0.00E+00	1.18E-01
ADP-minerals & metals[1]	kg Sb eq.	3.94E-06	2.63E-07	7.66E-08	9.87E-08	1.81E-09	0.00E+00	1.92E-08	3.04E-08	0.00E+00	1.20E-08	0.00E+00	4.45E-06
ADP-fossil[1]	MJ	3.62E+02	8.59E+01	3.28E+01	3.22E+01	3.96E-01	0.00E+00	5.15E+00	9.91E+00	0.00E+00	3.33E+00	0.00E+00	5.32E+02
WDP[1]	m^3 eq.	4.05E+00	-1.44E-02	5.23E+00	-5.39E-03	1.36E-03	0.00E+00	1.33E-03	-1.66E-03	0.00E+00	1.34E-03	0.00E+00	9.27E+00

Caption: GWP=Global Warming Potential, ODP=Ozone depletion potential, AP=Acidification potential, EP=Eutrophication potential, POCP=Photochemical ozone formation, ADPE=Abiotic depletion potential of abiotic resources ADPE, ADPF=Abiotic depletion potential for fossil resources, WDP=Water scarcity potential.

[1] The results of this environmental impact indicator must be used with caution, given that the uncertainties about these results are high or given that.

The additional environmental impact indicators relating to the Particulate Matter emissions, Ionizing radiation, human health, Eco-toxicity (freshwater), Human toxicity, cancer effects, Human toxicity, non-cancer effects, Land use related impacts/Soil quality categories were not included in the study.

TABLE 8 ENVIRONMENTAL IMPACT INDICATORS PER UD OF BIO BETON PRONTO

Indicator	Unit of measurement	Production phase			Distribution phase		Use phase	End of life phase				Beyond the system boundaries	Total
		A1	A2	A3	A4	A5	B1	C1	C2	C3	C4	D	
GWP-total	kg CO_2 eq.	-3.29E+01	4.89E+00	1.24E+00	2.45E+00	4.58E-01	-4.49E+00	2.14E-01	4.09E-01	0.00E+00	-3.83E+00	0.00E+00	-3.16E+01
GWP-fossil	kg CO_2 eq.	2.76E+01	4.89E+00	1.24E+00	2.44E+00	4.58E-01	-4.49E+00	2.14E-01	4.09E-01	0.00E+00	-3.83E+00	0.00E+00	2.89E+01
GWP-biogenic	kg CO_2 eq.	-6.05E+01	1.54E-03	6.49E-03	7.78E-04	2.32E-05	0.00E+00	6.10E-05	1.28E-04	0.00E+00	7.42E-05	0.00E+00	-6.05E+01
GWP-luluc	kg CO_2 eq.	1.62E-02	3.91E-05	8.90E-04	1.98E-05	6.18E-07	0.00E+00	5.29E-06	3.26E-06	0.00E+00	4.90E-06	0.00E+00	1.71E-02
ODP	kg CFC11 eq.	2.04E-06	1.15E-06	5.60E-08	5.80E-07	1.45E-09	0.00E+00	4.80E-08	9.56E-08	0.00E+00	2.99E-08	0.00E+00	4.00E-06
AP	mol H^+ eq.	1.21E-01	1.64E-02	5.09E-03	8.49E-03	6.61E-05	0.00E+00	2.31E-03	1.38E-03	0.00E+00	1.48E-03	0.00E+00	1.57E-01
EP-freshwater	kg P eq.	1.20E-02	1.97E-05	3.13E-04	9.98E-06	2.63E-07	0.00E+00	1.29E-06	1.65E-06	0.00E+00	4.27E-06	0.00E+00	1.24E-02
EP-marine	kg N eq.	8.78E-02	5.17E-03	9.77E-04	2.72E-03	1.15E-04	0.00E+00	1.04E-03	4.36E-04	0.00E+00	6.45E-04	0.00E+00	9.89E-02
EP-terrestrial	mol N eq.	3.24E-01	5.69E-02	9.94E-03	2.99E-02	3.23E-04	0.00E+00	1.14E-02	4.78E-03	0.00E+00	7.06E-03	0.00E+00	4.44E-01
POCP	kg NMVOC eq.	3.90E-02	1.56E-02	4.42E-03	8.15E-03	8.68E-05	0.00E+00	3.11E-03	1.31E-03	0.00E+00	1.97E-03	0.00E+00	7.35E-02
ADP-minerals & metals[1]	kg Sb eq.	3.68E-06	2.10E-07	1.55E-07	1.06E-07	5.35E-10	0.00E+00	1.11E-08	1.75E-08	0.00E+00	6.93E-09	0.00E+00	4.19E-06
ADP-fossil[1]	MJ	2.06E+02	6.85E+01	3.26E+01	3.46E+01	8.39E-02	0.00E+00	2.96E+00	5.71E+00	0.00E+00	1.92E+00	0.00E+00	3.52E+02
WDP[1]	m^3 eq.	3.56E+00	-1.15E-02	3.66E+00	-5.79E-03	5.66E-04	0.00E+00	7.63E-04	-9.55E-04	0.00E+00	7.74E-04	0.00E+00	7.21E+00

Legenda: GWP=Global Warming Potential, ODP=Ozone depletion potential, AP=Acidification potential, EP=Eutrophication potential, POCP=Photochemical ozone formation, ADPE=Abiotic depletion potential of abiotic resources ADPE, ADPF=Abiotic depletion potential for fossil resources, WDP=Water scarcity potential.

[1] The results of this environmental impact indicator must be used with caution, given that the uncertainties about these results are high or given that

The additional environmental impact indicators relating to the Particulate Matter emissions, Ionizing radiation, human health, Eco-toxicity (freshwater), Human toxicity, cancer effects, Human toxicity, non-cancer effects, Land use related impacts/Soil quality categories were not included in the study.

TABLE 9 ENVIRONMENTAL IMPACT INDICATORS PER UD OF BIO BETON JET

Indicator	Unit of measurement	Production phase			Distribution phase		Use phase	End of life phase				Beyond the system boundaries	Total
		A1	A2	A3	A4	A5	B1	C1	C2	C3	C4	D	
GWP-total	kg CO_2 eq.	-2.26E+01	5.15E+00	-8.77E-01	1.56E+00	2.96E+00	-6.73E+00	2.59E-01	4.96E-01	0.00E+00	-1.15E+01	0.00E+00	-3.12E+01
GWP-fossil	kg CO_2 eq.	3.79E+01	5.15E+00	4.20E-01	1.56E+00	5.14E-01	-6.73E+00	2.59E-01	4.95E-01	0.00E+00	-1.15E+01	0.00E+00	2.81E+01
GWP-biogenic	kg CO_2 eq.	-6.05E+01	1.62E-03	-1.30E+00	4.96E-04	2.44E+00	0.00E+00	7.39E-05	1.55E-04	0.00E+00	8.98E-05	0.00E+00	-5.93E+01
GWP-luluc	kg CO_2 eq.	1.62E-02	4.12E-05	2.80E-03	1.26E-05	4.35E-05	0.00E+00	6.40E-06	3.94E-06	0.00E+00	5.93E-06	0.00E+00	1.91E-02
ODP	kg CFC11 eq.	2.68E-06	1.21E-06	5.34E-08	3.70E-07	7.33E-08	0.00E+00	5.81E-08	1.16E-07	0.00E+00	3.62E-08	0.00E+00	4.60E-06
AP	mol H^+ eq.	1.32E-01	1.73E-02	3.15E-03	5.42E-03	2.37E-03	0.00E+00	2.79E-03	1.67E-03	0.00E+00	1.79E-03	0.00E+00	1.66E-01
EP-freshwater	kg P eq.	1.20E-02	2.08E-05	7.30E-04	6.36E-06	1.13E-04	0.00E+00	1.56E-06	1.99E-06	0.00E+00	5.17E-06	0.00E+00	1.29E-02
EP-marine	kg N eq.	8.98E-02	5.46E-03	1.08E-03	1.73E-03	4.65E-04	0.00E+00	1.25E-03	5.27E-04	0.00E+00	7.80E-04	0.00E+00	1.01E-01
EP-terrestrial	mol N eq.	3.47E-01	6.01E-02	1.05E-02	1.91E-02	4.33E-03	0.00E+00	1.38E-02	5.79E-03	0.00E+00	8.55E-03	0.00E+00	4.69E-01
POCP	kg NMVOC eq.	4.78E-02	1.64E-02	3.09E-03	5.19E-03	1.21E-03	0.00E+00	3.76E-03	1.58E-03	0.00E+00	2.38E-03	0.00E+00	8.14E-02
ADP-minerals & metals[1]	kg Sb eq.	3.70E-06	2.21E-07	3.79E-08	6.76E-08	1.24E-08	0.00E+00	1.34E-08	2.12E-08	0.00E+00	8.39E-09	0.00E+00	4.08E-06
ADP-fossil[1]	MJ	2.46E+02	7.22E+01	6.45E+00	2.21E+01	7.92E+00	0.00E+00	3.59E+00	6.91E+00	0.00E+00	2.32E+00	0.00E+00	3.67E+02
WDP[1]	m^3 eq.	3.64E+00	-1.21E-02	2.73E-01	-3.69E-03	3.03E+00	0.00E+00	9.24E-04	-1.16E-03	0.00E+00	9.37E-04	0.00E+00	6.93E+00

Legenda: GWP=Global Warming Potential, ODP=Ozone depletion potential, AP=Acidification potential, EP=Eutrophication potential, POCP=Photochemical ozone formation, ADPE=Abiotic depletion potential of abiotic resources ADPE, ADPF=Abiotic depletion potential for fossil resources, WDP=Water scarcity potential.

[1] The results of this environmental impact indicator must be used with caution, given that the uncertainties about these results are high or given that.

The additional environmental impact indicators relating to the Particulate Matter emissions, Ionizing radiation, human health, Eco-toxicity (freshwater), Human toxicity, cancer effects, Human toxicity, non-cancer effects, Land use related impacts/Soil quality categories were not included in the study.

TABLE 10 INDICATORS OF CONSUMPTION OF RESOURCES PER UD OF BLOCCO AMBIENTE

Indicator	Unit of measurement	Production phase			Distribution phase		Use phase	End of life phase				Beyond the system boundaries	Total
		A1	A2	A3	A4	A5	B1	C1	C2	C3	C4	D	
PENRE	MJ	3.62E+02	8.59E+01	2.60E+01	3.22E+01	3.96E-01	0.00E+00	5.15E+00	9.91E+00	0.00E+00	3.33E+00	0.00E+00	5.25E+02
PENRM	MJ	0.00E+00	0.00E+00	6.76E+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	6.76E+00
PENRT	MJ	3.62E+02	8.59E+01	3.28E+01	3.22E+01	3.96E-01	0.00E+00	5.15E+00	9.91E+00	0.00E+00	3.33E+00	0.00E+00	5.32E+02
PERE	MJ	2.87E+01	1.32E-01	7.36E+00	4.94E-02	1.93E-03	0.00E+00	8.31E-03	1.52E-02	0.00E+00	1.39E-02	0.00E+00	3.62E+01
PERM	MJ	5.89E+02	0.00E+00	6.78E+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	6.57E+02
PERT	MJ	6.18E+02	1.32E-01	7.52E+01	4.94E-02	1.93E-03	0.00E+00	8.31E-03	1.52E-02	0.00E+00	1.39E-02	0.00E+00	6.93E+02
FW	m3	1.84E-01	2.36E-04	1.21E-01	8.84E-05	2.93E-04	0.00E+00	8.69E-05	2.72E-05	0.00E+00	7.12E-05	0.00E+00	3.05E-01
MS	kg	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	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Legenda: PENRE=Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PERE=Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PENRM=Use of non-renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PENRT=Total use of non- renewable primary energy resources ; PERT=Total use of renewable primary energy resources; FW=Use of net fresh water; MS=Use of secondary material; RSF=Use of renewable secondary fuels; NRSF=Use of non-renewable secondary fuels.

TABLE 11 INDICATORS OF CONSUMPTION OF RESOURCES PER UD OF BIO BETON PRONTO

Indicator	Unit of measurement	Production phase			Distribution phase		Use phase	End of life phase				Beyond the system boundaries	Total
		A1	A2	A3	A4	A5	B1	C1	C2	C3	C4	D	
PENRE	MJ	-1.15E-03	8.59E+01	1.54E+01	3.22E+01	3.96E-01	0.00E+00	5.15E+00	9.91E+00	0.00E+00	3.33E+00	0.00E+00	1.52E+02
PENRM	MJ	1.15E-03	0.00E+00	1.17E-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	1.29E-02
PENRT	MJ	0.00E+00	8.59E+01	1.55E+01	3.22E+01	3.96E-01	0.00E+00	5.15E+00	9.91E+00	0.00E+00	3.33E+00	0.00E+00	1.52E+02
PERE	MJ	5.67E+01	1.32E-01	7.52E+01	4.94E-02	1.93E-03	0.00E+00	8.31E-03	1.52E-02	0.00E+00	1.39E-02	0.00E+00	1.32E+02
PERM	MJ	5.61E+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	0.00E+00	0.00E+00	5.61E+02
PERT	MJ	6.18E+02	1.32E-01	7.52E+01	4.94E-02	1.93E-03	0.00E+00	8.31E-03	1.52E-02	0.00E+00	1.39E-02	0.00E+00	6.93E+02
FW	m3	1.35E-01	1.88E-04	8.32E-02	9.50E-05	7.52E-05	0.00E+00	5.00E-05	1.57E-05	0.00E+00	4.10E-05	0.00E+00	2.19E-01
MS	kg	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	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Legenda: PENRE=Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PERE=Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PENRM=Use of non-renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PENRT=Total use of non- renewable primary energy resources ; PERT=Total use of renewable primary energy resources; FW=Use of net fresh water; MS=Use of secondary material; RSF=Use of renewable secondary fuels; NRSF=Use of non-renewable secondary fuels.

TABLE 12 INDICATORS OF CONSUMPTION OF RESOURCES PER UD OF BIO BETON JET

Indicator	Unit of measurement	Production phase			Distribution phase		Use phase	End of life phase				Beyond the system boundaries	Total
		A1	A2	A3	A4	A5	B1	C1	C2	C3	C4	D	
PENRE	MJ	2.46E+02	7.22E+01	6.45E+00	2.21E+01	7.92E+00	0.00E+00	3.59E+00	6.91E+00	0.00E+00	2.32E+00	0.00E+00	7.09E+02
PENRM	MJ	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	0.00E+00	0.00E+00
PENRT	MJ	2.46E+02	7.22E+01	6.45E+00	2.21E+01	7.92E+00	0.00E+00	3.59E+00	6.91E+00	0.00E+00	2.32E+00	0.00E+00	7.09E+02
PERE	MJ	1.84E+01	1.11E-01	2.42E+00	3.38E-02	2.62E+00	0.00E+00	5.79E-03	1.06E-02	0.00E+00	9.71E-03	0.00E+00	4.72E+01
PERM	MJ	5.61E+02	0.00E+00	3.52E+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	1.19E+03
PERT	MJ	5.79E+02	1.11E-01	3.76E+01	3.38E-02	2.62E+00	0.00E+00	5.79E-03	1.06E-02	0.00E+00	9.71E-03	0.00E+00	1.24E+03
FW	m3	1.46E-01	1.98E-04	8.68E-03	6.06E-05	6.93E-02	0.00E+00	6.06E-05	1.90E-05	0.00E+00	4.96E-05	0.00E+00	4.49E-01
MS	kg	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	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Legenda: PENRE=Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PERE=Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PENRM=Use of non-renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PENRT=Total use of non- renewable primary energy resources ; PERT=Total use of renewable primary energy resources; FW=Use of net fresh water; MS=Use of secondary material; RSF=Use of renewable secondary fuels; NRSF=Use of non-renewable secondary fuels.

TABLE 13 OUTPUT FLOWS AND GENERATED WASTE PER UD OF BLOCCO AMBIENTE

Indicator	Unit of measurement	Production phase			Distribution phase		Use phase	End of life phase				Beyond the system boundaries	Total
		A1	A2	A3	A4	A5	B1	C1	C2	C3	C4	D	
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	99.00	0.00	99.02
RWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.66
MFR	kg	0.00	0.00	4.95	0.00	1.15	0.00	0.00	0.00	0.00	0.00	0.00	1.15
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.10
ETE	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Legenda: HWD=Hazardous waste disposed; NHW=Non-hazardous waste disposed; RWD=Radioactive waste disposed; MER=Materials for energy recovery; MFR=Materials for recycling; CRU=Components for re-use; EET=Exported thermal energy; EEE=Exported electrical energy.

TABLE 14 OUTPUT FLOWS AND GENERATED WASTE PER UD OF BIO BETON PRONTO

Indicator	Unit of measurement	Production phase			Distribution phase		Use phase	End of life phase				Beyond the system boundaries	Total
		A1	A2	A3	A4	A5	B1	C1	C2	C3	C4	D	
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	57.00	0.00	57.04
RWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.15
MFR	kg	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.15
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ETE	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Legenda: HWD=Hazardous waste disposed; NHW=Non-hazardous waste disposed; RWD=Radioactive waste disposed; MER=Materials for energy recovery; MFR=Materials for recycling; CRU=Components for re-use; EET=Exported thermal energy; EEE=Exported electrical energy.

TABLE 15 OUTPUT FLOWS AND GENERATED WASTE PER UD OF BIO BETON JET

Indicator	Unit of measurement	Production phase			Distribution phase		Use phase	End of life phase				Beyond the system boundaries	Total
		A1	A2	A3	A4	A5	B1	C1	C2	C3	C4	D	
HWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NHWD	kg	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	69.00	0.00	69.03
RWD	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.25
MFR	kg	0.00	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.88
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ETE	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Legenda: HWD=Hazardous waste disposed; NHW=Non-hazardous waste disposed; RWD=Radioactive waste disposed; MER=Materials for energy recovery; MFR=Materials for recycling; CRU=Components for re-use; EET=Exported thermal energy; EEE=Exported electrical energy.

» CALCULATION PROCEDURE

DECLARED UNIT

This study is based on a declared unit. The same declared unit was considered, equal to 1 m2 of wall with a thickness of 30 cm, for all three products analysed. In the case of the Blocco Ambiente®, this corresponds to ten 50x20x30 cm bricks. In the case of Bio Beton® Pronto and Bio Beton® 200 Jet, this corresponds to 0.30 m3 of product.

REFERENCE SERVICE LIFE

100 YEARS – LCA carried out with “from cradle to gate with options” approach

EXCLUSION FROM THE BOUNDARIES OF THE SYSTEM

In compliance with the reference PCR, operations relating to the production, transport and installation of instrumental goods (machinery, packaging for internal transport) and general operations (staff travel, marketing and communication actions) are excluded from the system boundaries since they are not directly related to the product being studied.

CUT-OFF

None.

ALLOCATION RULES

Several co-products are obtained from the hemp plant: fibre, seeds, hemp shiv and powders. In accordance with the reference standard, the economic allocation was selected for the allocation of the impacts of the hemp production process, with the exception of the intrinsic physical properties of the material (biogenic carbon content and primary energy content), which have been physically allocated. The “cut-off” approach was adopted.

GEOGRAPHICAL AND TEMPORAL LOCATION

The production site is located in Montichiari (Brescia). The average distance between the factory and the construction sites is 150 km. The raw materials come from northern Italy and France.
The reference year of the study is 2020.

SOURCE AND QUALITY OF DATA

This EPD is based on primary data for the aspects considered essential: the consumption of raw materials, the origin of the raw materials and the mode of transport to the production site, the consumption of water and electricity in the production and installation phases, primary and secondary packaging of the products. Secondary data were modelled using ecoinvent 3.8 (https://www.ecoinvent.org/) and Agri-footprint 5.0 (https://blonksustainability.nl/tools/agri-footprint) database.

ACCURACY, CONSISTENCY AND COMPLETENESS OF THE DATA

In order to guarantee the required accuracy and consistency, this study used primary information provided directly by the company for the “foreground” data relating to the manufacture of the products themselves and the transport of raw materials to the manufacturing site. This is in line with what is indicated by the reference standard EN15804:2013+A2:2019, which requires that specific data be used at least for the processes over which the manufacturer exercises direct control. The primary data collected were completed with data from literature and with background data contained in the ecoinvent 3.8 database, whose consistency and transparency are recognized worldwide (https://www.ecoinvent.org/). The detailed exchange of information with the company and the use of the ecoinvent database also made it possible to achieve a good degree of completeness of the information.

DATA REPRESENTATIVENESS

The primary data collected for the inventory of modules A2 and A3 of the Production phase, for module A4 and for water and energy consumption in module A5 of the Construction phase are site-specific primary data provided by the manufacturer and therefore have a high geographical, technological and temporal representativeness. The datasets used for the retrieval of secondary data belong to the ecoinvent 3.8 database and are all applicable for the year 2020, the reference year of the study. Only in the case of the production of molasses for the growth of microorganisms, a dataset belonging to the Agri-Footprint 5.0 database was used, also valid for the year 2020. Data relating to the reference nation were used where possible and data referring to a wider geographical area where national data were not applicable.

CALCULATION METHODS

The following methods were used to calculate the impacts:

- EN 15804 + A2 Method V1.02
- Cumulative Energy Demand (LHV) V1.00
- ReCiPe 2016 Midpoint (H) V1.06 / World (2010) H
- EDIP 2003 v1.07

» SCENARIOS ANALYSED

PRODUCTION PHASE

The Production phase includes the following LCA modules:

- A1, raw materials production;
- A2, transport of raw materials to the production site;
- A3, product manufacture.

The supply and transport of all raw materials required for the manufacture of the products were considered. As regards the production of hemp shiv, the withdrawal of carbon dioxide due to photosynthesis carried out by the plant has been included in the hemp cultivation model. The following co-products of hemp cultivation were considered: fibres, seeds, hemp shiv, powders. The consumption of water and energy and the emissions of the production process, as well as the production of packaging, were also included. The production of electricity used in the production plant was modelled in accordance with the ecoinvent 3.8 dataset relating to the Italian electricity mix. In the case of Blocco Ambiente®, during the maturing phase of the production process, included in module A3, the withdrawal of CO2 from the atmosphere due to carbonatation was also considered.

CONSTRUCTION PHASE

The Construction phase includes the following LCA modules:

- A4, transport to the construction site;
- A5, installation

Module A4 considers transportation from the production plant to the construction site, according to the scenario described in the Table.
Module A5 includes the installation of products, which in the case of Bio Beton® Jet involves water and electricity consumption, while for Blocco Ambiente® and Bio Beton® Pronto it takes place manually, without further consumption. In addition, the disposal and treatment of packaging waste is included in module A4. The end-of-life scenario of the packaging was made on the basis of the state of the art. In particular, the percentages of wood, plastic and paper sent to the various treatments (recycling, energy recovery, landfill) were defined on the basis of the documentation published by sector associations: Rilegno (https://www.rilegno.org/), Plastics Europe (https:// plasticseurope.org/), Comieco (https://www.comieco.org/).

TABLE 16 INFORMATION ON THE TRANSPORT SCENARIO AT THE INSTALLATION SITE

INFORMATION ABOUT THE SCENARIO	BLOCCO AMBIENTE	BIO BETON PRONTO	BIO BETON JET
Type of vehicle used for transport	Light commercial vehicle		
Distance [km]	150 km		
Use of capacity	% assumed by ecoinvent 3.8		
Transported weight per UDb [kg/UD]	109.84	117.95	75.20

[a] Includes product, packaging and machinery. [b] Volume UD = 0.3 m^3.

TABLE 17 INFORMATION ON THE INSTALLATION SCENARIO

INFORMATION ABOUT THE SCENARIO	BLOCCO AMBIENTE	BIO BETON PRONTO	BIO BETON JET
Water usage [m3/UD]	Water is not used during installation.		0.06
Electricity used during installation [kWh/UD]	Water is not used during installation.		1.35
Waste materials on site generated by the installation of the product [kg/UD]	Wood: 1.87 Plastic: 0.15	Plastic: 0.35	Wood: 0.59 Paper: 0.56
End of life of packaging	Wood: 65% recycled; 35% energy recovery Plastic: 44% recycled; 43% energy recovery; 13% landfill Paper: 87% recycled; 8% energy recovery; 5% landfill		

USE PHASE (B1)

During the Use phase, only module B1 relating to transport to the construction site was considered. The withdrawal of carbon dioxide from the atmosphere due to carbonatation was considered in this module.

END OF LIFE PHASE (C1 - C4)

The end of life phase includes the following modules:

- C1, decommissioning and demolition;
- C2, demolition waste transport;
- C3, demolition waste treatment;
- C4, demolition waste disposal.

Since the products considered have been placed on the market in recent times, there is no reliable information regarding their end-of-life scenario. For this reason, it has been assumed that they are entirely disposed of in landfills as inert materials. A hypothetical distance from the demolition site to the waste collection centre of 100 km was assumed. During the permanence in the landfill, the carbonatation of the binder continues.

CARBONATATION

The dolomitic lime used as a binder in the products being studied is characterized by three possible carbonatation reactions which are distinguished by the formation of calcium or magnesium carbonate, as reported in Eq. 1, Eq. 2 ed Eq. 3.

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O \quad (1)$$
$$CaCO_3 + MgO + CO_2 \longrightarrow CaMg(CO_3)_2 \quad (2)$$
$$Mg(OH)_2 + CO_2 \longrightarrow MgCO_3 + H_2O \quad (3)$$

For the calculation of carbonatation, the standard EN ISO 16757:2017 was used as a reference, which refers to the carbonatation of concrete or products containing concrete, this is the type of material closest to the one being studied for which a standard relating to carbonatation is available. To define the volume affected by carbonatation in a certain period of time, the depth of carbonatation was calculated using Eq. 4:

$$d = k\sqrt{t} \quad (4)$$

where d is the depth of carbonatation [mm], k is a value related to the service conditions of the material [mm/year 0.5] and t is the time [years]. In the case being studied, k is equal to 11, which is the value to be used in case of application in buildings sheltered from rain. The percentage of binder contained in the volume affected by the phenomenon that is actually carbonated is defined by the degree of carbonatation (Dc), which in the conditions analysed in this study is equal to 75%. Based on the composition of the lime used, it was determined that the percentage of binder that has an active part for carbonatation is 87%, while the remaining 13% is given by the sum of the carbonates already present in the binder and the impurities.

By applying Eq. 3 the depth of carbonatation during the service life (100 years) was determined, the result being 11 cm. In the case of the Blocco Ambiente®, the carbonatation depth for the maturing phase (6 months) was also calculated, the resulting being 8 mm. Finally, for all products it was assumed that the material sent to landfill at the end of life (module C4) completes the carbonatation process.

» ADDITIONAL INFORMATION

TABLE 17 CO_2 STORAGE PER CUBE METER OF PRODUCT

U.D.M.	BLOCCO AMBIENTE	BIO BETON PRONTO	BIO BETON JET
kg CO_2 eq./m^3	-44.2	-105.3	-104.0

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