



Environmental Product Declaration (EPD)

of secondary raw
materials or
aggregates of
industrial origin

SAND
MATRIX

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1 DESCRIPTION OF THE COMPANY AND THE PRODUCT

1.1 The company



Officina dell'Ambiente S.p.A, located in the municipality of Lomello in Pavia province, performs the treatment and recovery process of special hazardous and non-hazardous wastes, mainly bottom ashes derived from municipal incineration plants to be re-used as secondary raw material for the production of cement and other building materials.

Thousands of tonnes of bottom ashes from incineration, instead of being disposed in landfill, are treated in a controlled manner through a treatment/recovery cycle which generates a secondary raw material, named Matrix®, as substitute of primary raw material for cement production and other building products.

Today, Matrix has become a family of products with different characteristics, particle size and application ranging over almost all building sectors. At the moment, representatives of the Matrix Family are:

- Matrix Standard, with a particle size between 0 and 10 mm;
- AGMatrix, with a particle size between 2 and 10 mm; this product has been EC-labelled as aggregate for concrete in 2008;
- Sand Matrix, a group of sands that can be produced in particle size of 0-2 mm, 0-4 mm and 2-4 mm.

1.2 Sand Matrix®

The main process of Officina dell'Ambiente S.p.A. is aimed to obtain the product named Matrix Standard, starting from bottom ashes derived from municipal incineration plants. The process involves a set of physical-mechanical treatments, without the addition of chemical reagents, consisting of a screening, crushing and separation of ferrous and non-ferrous metals.

More in detail, the main production process of Officina dell'Ambiente S.p.A. consists of the following phases:

- acceptance of the waste;

The recovery of incineration bottom ashes, otherwise disposed in landfill, allows to conserve resources mitigating the demand for raw materials and the depletion of natural resources.

Officina dell'Ambiente S.p.A. complies with European Union Directives that provide a management policy aimed at minimizing waste production, focusing on their recovery rather than their disposal.

Officina dell'Ambiente S.p.A. supplies several cement plants and producers of concrete with a wide range of products as substitutes of primary raw materials with the dual purpose of removing a considerable flow of waste from landfill and to preserve the reserves of natural materials.

Officina dell'Ambiente S.p.A. holds the Environmental Management System certificate according to the scheme of UNI EN ISO 14001:2004, which has the following scope: *treatment and recovery of specific hazardous and non-hazardous waste through the phases of weighing, unloading, storage and physical-mechanical separation.*

The headquarters of Officina dell'Ambiente S.p.A, which corresponds to the production site, is the following:

Strada Provinciale 193bis – Tenuta Grua, Lomello (PV)

This site is registered under EC Regulation 1221/09 EMAS from 30/8/2006 with the number 555 (Environmental verifier DNV Italy).

- unloading of the waste in specific areas of the production site;
- waste maturation process;
- loading of the waste through loading hoppers and transferring to the treatment plant;
- screening and separation of the waste;
- crushing and separation of ferrous metals from unscreened waste;
- storage of Matrix Standard in specific areas of the production site;

- picking and selling of the finished product.

Following the production of Matrix Standard, Officina dell'Ambiente has built in the external area of the plant a system of vibrating sieves working without the use of water, which separates Matrix Standard into the fractions with particle size 0-4 mm, 2-10 mm and >10 mm (which is sent back to the crushing system). The fraction with particle size 0-4 mm (Sand Matrix 0-4 mm) is further separated into the fractions with particle size 0-2

mm (Sand Matrix 0-2 mm) and 2-4 mm (Sand Matrix 2-4 mm) using the vibrating sieves.

All Sand Matrix products (0-2, 0-4, 2-4 mm) own characteristics and specific EC marking for various sectors, such as the production of concrete, pre-measured mortars, bituminous conglomerate, brick and cement mixtures.

As required by PCR document 2012:01, in Matrix products there are no substances with a high degree of concern (SVHC) provided in the ECHA Candidate List with a concentration greater than 0,1%.

Product	U.M.	Quantity			
		2009	2010	2011	average
Sand Matrix 0-2 mm	ton	3.458	1.927	25.990	10.459
Sand Matrix 2-4 mm	ton	0	0	3.022	1.007
Sand Matrix 0-4 mm	ton	10.975	7.361	7.974	8.770

Table 1: Quantity of Sand Matrix sold from 2009 to 2011

Declared Unit

1000 kg of Matrix product

The phases of distribution, use and disposal of the product are not included in the study

1.3 Composition of the product

Parameter	U.M.	Sand Matrix	Parameter	U.M.	Sand Matrix
Humidity	%	14,58	As	mg/kg	13,45
SiO ₂	% s.s.	31,52	Cd	mg/kg	16,55
Al ₂ O ₃	% s.s.	11,94	Cr (total)	mg/kg	737,55
Fe ₂ O ₃	% s.s.	11,32	Cr (VI)	mg/kg	< 1
CaO	% s.s.	20,49	Cu	mg/kg	5.890,00
MgO	% s.s.	2,74	Hg	mg/kg	< 5
Na ₂ O	% s.s.	2,10	Mn	mg/kg	1.244,36
K ₂ O	% s.s.	0,90	Ni	mg/kg	233,36
TiO ₂	% s.s.	0,99	Pb	mg/kg	3.180,55
Mn ₂ O ₃	% s.s.	0,18	Sb	mg/kg	138,09
Cr ₂ O ₃	% s.s.	0,11	Se	mg/kg	< 5
S (total)	% s.s.	0,57	V	mg/kg	37,55
SO ₃	% s.s.	1,42	Zn	mg/kg	5.772,09
P ₂ O ₅	% s.s.	1,76			
Cl	% s.s.	0,45			
CaCO ₃	% s.s.	11,41			
Loss on ignition (550°C)	% s.s.	7,92			

Table 2: Average chemical composition of Sand Matrix produced in 2011

1.4 System boundaries

System boundaries determine the unit processes to be included in LCA study and which data as "input" and/or "output" to/from the system can be omitted. According to the PCR 2012:01, the life cycle of Matrix products is divided into upstream and core phases, as specified below. The upstream phase comprises the supply of raw materials and specifically:

- the extraction and processing of raw materials and recycling processes of the secondary raw materials from the previous product system (with the exception of the processes which are part of the waste treatment of the previous product system);
- the electricity generation from primary energy sources, including their extraction, refining and distribution;

- energy recovery from secondary fuels (with the exception of processes which are part of the waste treatment in the system of the previous product).

The core phase includes the following processes:

- external and internal transport between processes belonging to the core phase;
- production of Matrix products;
- treatment of waste derived from the production of Matrix products.

The downstream phase is not included in the system boundaries. In the figure below it is shown the schematic diagram of the life.

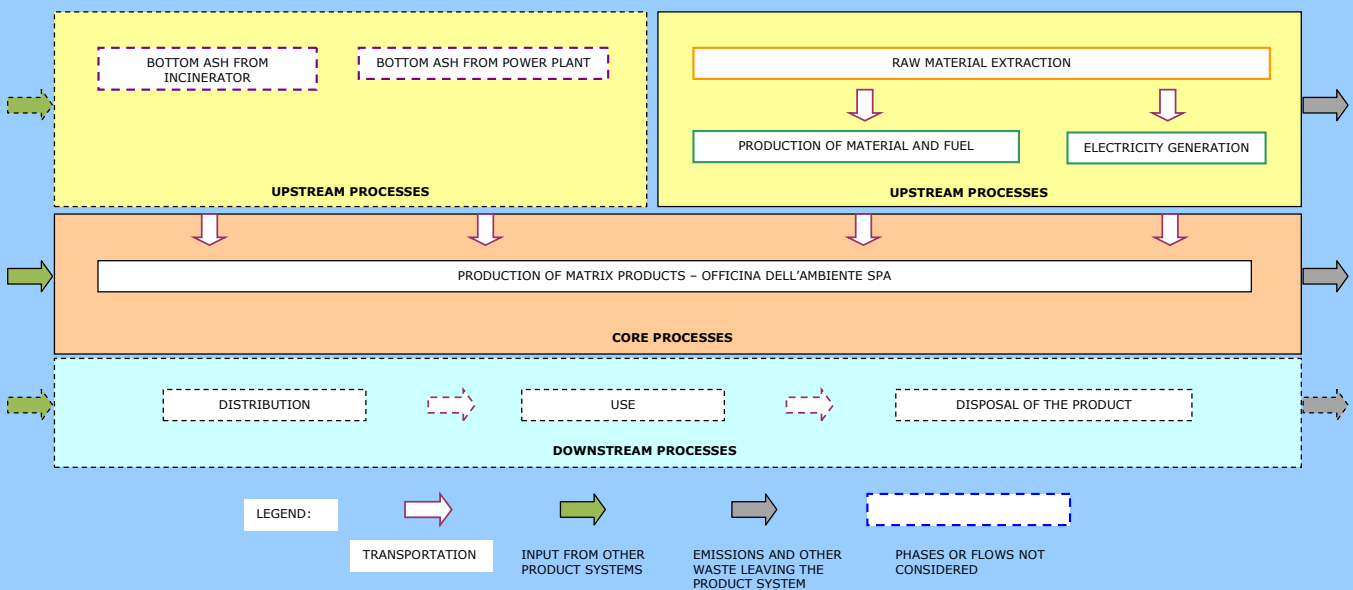


Figure 1: System boundaries

1.5 Data quality

The inventory analysis was conducted using specific data provided by Officina dell'Ambiente SpA concerning the consumption of raw materials and electricity, the production of Matrix products and related waste. All data refer to the last three years (2009, 2010 and 2011) while in the model the average values were used. The electricity consumed by Officina dell'Ambiente is produced from hydroelectric and photovoltaic sources.

Selected generic data was used from international databases (in particular Ecoinvent 2.2) regarding the production processes of the auxiliary materials used for the production of Matrix products, the processes of generation and distribution of electricity, the means of transportation and

waste treatment processes related to the production of Matrix products. Furthermore, the distances of transportation were calculated using Google Maps online calculator. Generic data was not used.

According to the PCR 2012:01, the following processes were excluded: the maturation process of the bottom ash, the accumulation and the process of natural weathering of the Matrix Standard because less than 1% of the total impact; the consumption of natural gas for heating offices, the travels of workers to and from work and the construction of machinery and plants, as not directly related to the product.

1.6 Distribution, use phase and disposal of the product

The distribution of the product, use phase and disposal of Matrix products were not considered

("cradle-to-gate" LCA study, i.e. from cradle to the gate of the company).

1.7 Comparison of EPD within the same product category

The EPD within the same product category but which refer to different programs can not be compared.

Sand Matrix products described in this document is based on specific PCR 2012:01 version 1.0 dated 09-01-2012.

1.8 Validity of EPD

This EPD refers to the geographical area of Italy and remains valid until the 1st of March 2016.

2 ENVIRONMENTAL PERFORMANCE

The environmental performance of Sand Matrix products, as described below, is based on the methodology of Life Cycle Assessment (LCA) and it was calculated in accordance with ISO 14040 and 14044, the International EPD system and PCR 2012:01. The management and update of environmental data concerning EPD products are

regulated by a specific procedure in the manual for the management systems of safety and the environment (EMAS). The radioactivity of bottom ash from incineration of municipal waste is monitored before sending to Officina dell'Ambiente in order to exclude the delivery of radioactive bottom ash.

1.9 Assessment methodology

The calculation method adopted for the LCA study of the present EPD is described in the document "GPI for an International EPD® System" and the characterization factors used to convert the data deriving from the inventory analysis of the life cycle into impact categories are listed in "Appendix B: Conversion and characterization factors". In addition to the impact categories re-

quired by PCR, the impact categories related to aquatic and terrestrial ecotoxicity, human toxicity and land use were also considered; these impact categories taken from the CML 2001 method developed by the Center of Environmental Science (CML) of Leiden University in the Netherlands (<http://cml.leiden.edu/software/data-cmlia.html>).

1.10 Environmental profile of Sand Matrix®

The impact categories, which characterize upstream and core phases and the life cycle of Sand Matrix 0-4 mm, refer to one tonne of product and as presented in the following table. The results of the impact categories of Sand Matrix 0-2 mm and Sand Matrix 2-4 mm are not shown because, ac-

cording to the GPI document, the difference from the Matrix Sand 0-4 mm is less than 5% for all impact categories (the maximum percentage difference is 0,4%). Resources whose contribution is greater than 5% of the total impact of one ton of Sand Matrix 0-4 mm, are also shown.

Impact Category	U.M.	Upstream	Core	Life cycle
Non renewable resources without energy content	kg	0,002	0,080	0,082
Non renewable resources with energy content	MJ eq	1,660	534,438	536,098
Renewable resources without energy content	kg	0,000	0,024	0,024
Renewable resources with energy content	MJ eq	32,100	0,846	32,946
Water consumption	litre	127.237,73	5.416,28	132.654,01
Electricity consumption in the core	MJ	n.a.	31,569	n.a.
Global warming potential 100 years	kg CO ₂ eq	0,041	44,357	44,398
Ozone depletion	mg CFC-11 eq	0,008	4,978	4,986
Photochemical smog oxidation	g C ₂ H ₄	0,130	34,528	34,658
Acidification	g SO ₂ eq	0,142	199,564	199,706
Eutrophication	g PO ₄ --- eq	0,034	54,073	54,107
Human toxicity 100 years	kg 1,4-DB eq	0,021	5,753	5,774
Water toxicity 100 years	kg 1,4-DB eq	0,004	58,491	58,495
Marine water ecotoxicity	kg 1,4-DB eq	0,016	186,027	186,043
Soil ecotoxicity 100 years	kg 1,4-DB eq	0,000	0,002	0,002
Land use	m ² a	0,000	0,010	0,010
The use of renewable secondary raw materials	kg	0,000	0,000	0,000
The use of non renewable secondary raw materials	kg	0,000	1,261	1,261
Reusable components	kg	0,000	0,000	0,000
Recyclable materials	kg	0,000	117,136	117,136
Materials for energy recovery	kg	0,000	0,000	0,000
Non-hazardous waste	kg	0,038	11,653	11,691
Hazardous waste	kg	0,001	0,046	0,047
Radioactive waste	m ³	0,000	0,000	0,000

Table 3: The environmental impacts of 1 tonne of Sand Matrix 0-4 mm

Consumption of non renewable resources without energy content	U.M.	Life cycle
Sodium chloride	kg	0,044
Calcite	kg	0,032
Other resources	kg	0,006
Total resources	kg	0,082

Consumption of non renewable resources with energy content	U.M.	Life cycle
Oil	MJ	494,564
Natural gas	MJ	30,718
Other resources	MJ	10,816
Total resources	MJ	536,098

Table 4: Non renewable resources whose contribution is greater than 5% of the total impact of one ton of Sand Matrix 0-4 mm

Consumption of renewable resources without energy content	U.M.	Life cycle
Carbon dioxide in air	kg	0,016
Softwood	kg	0,005
Hardwood	kg	0,003
Other resources	kg	0,000
Total resources	kg	0,024

Consumption of renewable resources with energy content	U.M.	Life cycle
Hydroelectric energy	MJ	29,465
Solar energy	MJ	3,256
Other resources	MJ	0,225
Total resources	MJ	32,946

Table 5: Renewable resources whose contribution is greater than 5% of the total impact of one ton of Sand Matrix 0-4 mm

Water consumption	U.M.	Life cycle
For hydroelectric production	litre	131996,070
Other uses	litre	657,933
Total consumption	litre	132654,010

Table 6: Water consumption for the production of one ton of Sand Matrix 0-4 mm

1.11 Additional environmental information

Comparison between Sand Matrix and sand production

Sand Matrix 0-2 mm was compared with sand, whose life cycle includes the extraction of the raw material, the handling inside the cave and the treatment of the extracted material; the life cycle of the sand was obtained from the Ecoinvent database (process “Sand, at mine/IT U”

modified with the Italian energy mix), ETH database (process “Sand ETH U”) and ELCD database (process “Sand 0/2, wet and dry quarry, production mix, at plant, undried RER S”). The following table presents the results of the comparison relative to 1 ton of product.

Impact category	U.M.	Sand Matrix 0-2 mm	Sand Matrix 0-2 mm with avoided impacts of slag disposal	Sand Matrix 0-2 mm with avoided impacts of slag disposal and primary production of iron and aluminium	Sand (Ecoinvent)	Sand (ETH)	Sand (ELCD)
Non renewable resources without energy content	kg	0,082	0,081	-111,798	1.040,023	1.000,014	430,073
Non renewable resources with energy content	MJ eq	535,859	506,719	-95,566	46,139	150,554	28,831
Renewable resources without energy content	kg	0,024	0,023	-0,200	0,089	0,002	7,859
Renewable resources without energy content	MJ eq	32,916	32,870	24,773	3,002	2,918	2,358
Water consumption	litre	132.535,030	132.275,510	79.794,124	13.016,932	14.455,569	4,197
Global warming potential 100 years	kg CO ₂ eq	44,382	42,303	-2,197	2,953	9,758	2,448
Ozone depletion	mg CFC-11 eq	4,984	4,719	2,596	0,355	10,355	0,181
Photochemical smog formation	g C ₂ H ₄	34,625	31,938	-65,092	3,249	26,118	2,018
Acidification	g SO ₂ eq	199,579	187,036	-122,099	14,689	40,524	17,105
Eutrophication	g PO ₄ --- eq	54,078	-461,733	-532,857	3,843	5,935	2,022
Human toxicity	kg 1,4-DB eq	5,765	-6,273	-41,044	0,969	1,019	0,085
Water ecotoxicity	kg 1,4-DB eq	58,495	-2.022,287	-2.059,610	0,242	0,510	0,001
Marine water ecotoxicity	kg 1,4-DB eq	186,041	-6.457,512	-6.592,230	0,967	2,648	0,066
Soil ecotoxicity	kg 1,4-DB eq	0,002	-0,001	-0,028	0,000	0,001	0,000
Land use	m ² a	0,010	-0,413	-0,587	0,298	0,000	0,000

Table 7: Results of the comparison between Sand Matrix 0-2 mm (without and with avoided impacts) and sand

From the table above, it can be noticed that there is a reduced consumption of non renewable resources without energy content of Sand Matrix as a result of the waste recovery (which are secondary raw materials), while the consumption of non renewable resources with energy content of Sand Matrix is mainly due to the transport of bottom ash from incinerators to Officina dell'Ambiente SpA; the consumption of renewable resources without energy content is not significant as it is related to biomass used for the production of electricity in the energy mix of European countries.

Instead, the consumption of renewable resources with energy content indicates that the extraction of the sand relies on traditional resources (fossil fuels) which is of the same order of magnitude as the consumption of electricity from renewable sources of Officina dell'Ambiente (excluding the process of ETH database). The water consumption is higher in the production of Sand Matrix because it refers for 99% to the production of electricity from hydroelectric source while the consumption related to the manufacturing process is lower than the water consumption of the sand (compared with the process of Ecoinvent database).

With regard to the indicators of global warming potential, depletion of the ozone layer, the formation of photochemical smog, acidification and eutrophication potentials, all impact categories are higher in the life cycle of Sand Matrix (compared with the process of Ecoinvent database): that is due to the higher consumption of fossil fuels.

Quality of Matrix products

Officina dell'Ambiente S.p.A. applies a production cycle that includes a series of self-limitations with the aim to further increase the level of assurance of the already high technical standards of the Matrix ®. In particular, bottom ashes produced by incinerators that treat special industrial waste are never delivered to Officina dell'Ambiente, even if that bottom ash could be theoretically compatible for its chemical and physical properties; other types of

Regarding toxicity indicators, all impact categories are higher in the life cycle of the Sand Matrix due to the higher consumption of fossil fuels and processes for the disposal of waste.

With regards to the comparison between the scenarios of Sand Matrix with and without avoided impacts of bottom ash, the greatest benefit is evident in the indicator of eutrophication as a result of avoided emissions into water of nitrate, phosphate and COD released by bottom ash.

With regards to the comparison between the scenarios of Sand Matrix with and without avoided impacts of bottom ash disposal in landfill (calculated modifying process "disposal, municipal solid waste, 22.9% water, to municipal incineration/kg/CH" of Ecoinvent database) and the primary production of iron and aluminium (calculated with processes "Sinter, iron, at plant/GLO U" and "Aluminium hydroxide, at plant/RER U" of Ecoinvent database), the greatest benefits are evident in the indicators of non renewable resources, with and without energy content and water consumption, due to the avoided supply of raw materials and fossil fuels (the latter contributes to the reduction of global warming potential); also in the indicator of formation of photochemical smog, due to the avoided emission of carbon monoxide derived from primary production of iron; also in the indicator of acidification, due to the avoided emission of sulphur dioxide derived from the primary production of iron.

teristics compatible with the limits of the law and regulations. All Matrix products are subject to strict controls: analysis includes the major inorganic constituents and heavy metals and are carried out on samples that represent the average production of the plant. Main organic pollutants are regularly measured on a monthly basis in the Matrix ® Standard and their values are always equal to zero or extremely low. Officina dell'Ambiente has set up a chemical laboratory equipped with modern instrumentation and directed by a chemist regularly enrolled with the professional Order. The instru-

mental equipment is able to realize inorganic analysis with particular reference to complex mineralogical matrices such as slag from incineration (ball mills, digester oven, muffle for mergers alkaline, inductively coupled plasma spectrometer for the determination of metals). In addition physical and mechanical tests are performed, as required to maintain the EC labels, and the same laboratory is suitable for carrying out independently mixtures of concrete and mortar together with a number of measurements according to the UNI EN rules. Alternatively, highly qualified external laboratories are employed.

Product certification

According to Directive 89/106/EC, building materials may be sold only if they possess EC marking in accordance to the corresponding technical standard. For almost all of the applications of Matrix products, EC marking is required.

Obtaining this marking requires the existence of the Quality Control System, known as FPC (Factory Production Control) that once implemented is subject to certification by an independent body (ICMQ, certificate number 1305-CPD-0661). Officina dell'Ambiente S.p.A. has been certified at the beginning of 2008 and the FPC system covers four products for a total of eight EC marking in accordance with the technical standard.

All products of the Matrix Family play an important role in the LEED certification scheme as they contribute to the achievement of credits related to the section "Materials and resources" either for category 4 (recycled content) and category 5 (regional materials) . To facilitate the acquisition of credits by customers working in eco-sustainable building, the recycled content in Matrix products, which is equal to 100% post-consumer waste, has been established using the requirements of the standard ISO 14021. The result is a self-declared environmental statement (in accordance with ISO 14021) whose accuracy has been subjected to independent validation of ICMQ certification.

Improvement goals

Based on the results of the LCA study and maintaining what has already been reported in the EMAS Environmental Declaration, improvement goals set by Officina dell'Ambiente for Matrix products include the extension of the CE marking

to one more Matrix product at least and the reduction of environmental impacts of Matrix products through the review of the logistics of transporting of waste input.

3 REFERENCES

- *Valutazione del ciclo di vita della famiglia di prodotti Matrix®: Matrix® Standard, Sand Matrix® e AGMatrix®, Ambiente Italia srl, 22 Febbraio 2013*
- *Dichiarazione Ambientale EMAS, Officina dell'Ambiente S.p.a., Reg. 1221/2009, Anno 2011*
- *General Programme Instructions for Environmental Product Declarations, version 1.0 dated 2008-02-29 PCR 2012:01 versione 1.0 datata 2012-01-09; Gruppo CPC: Construction products*
- *PCR 2012:01 versione 1.0 datata 2012-01-09; Gruppo CPC: Construction products*
- *ISO 14040:2006 Environmental management – Life cycle assessment - Principles and Framework*
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International EPD® system

<http://www.environdec.com>

EPD from the same product category but referring to different programmes can not be compared.

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Independent verification of the declaration and data, according to ISO 14025

The third-party verification was conducted by Vito D'Incognito Via Vallazze 95 Milano tel. +39 02 2663461 email vdincognito@tin.it accredited by the Technical Committee of the International EPD® System.

The certification body Bureau Veritas Italia is the manager of the contract with Officina dell'Ambiente.