PLATFORM MEETING

L'esperienza dei Progetti LIFE per la sostenibilità ambientale dell'industria Ceramica e dei Laterizi

Sustainable recycling in polyvalent use of energy saving building elements

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PROGETTO LIFE13 ENV/IT/000535

Sassuolo – 11 aprile 2017

FEDERAZIONE CONFINDUSTRIA CERAMICA E LATERIZI

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE

CENTRO CERAMICO

AIM OF PROJECT

Design and production of

New <u>POROUS</u> products, glasses and glass ceramics:

(innovative building materials: bricks, panels, internal and external pavements)

Consist of at least **90% of waste product**;

Be obtained by a production cycle that foresees

low temperature reactive sintering (T < 750 °C);

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MAMMA ROSA'S project

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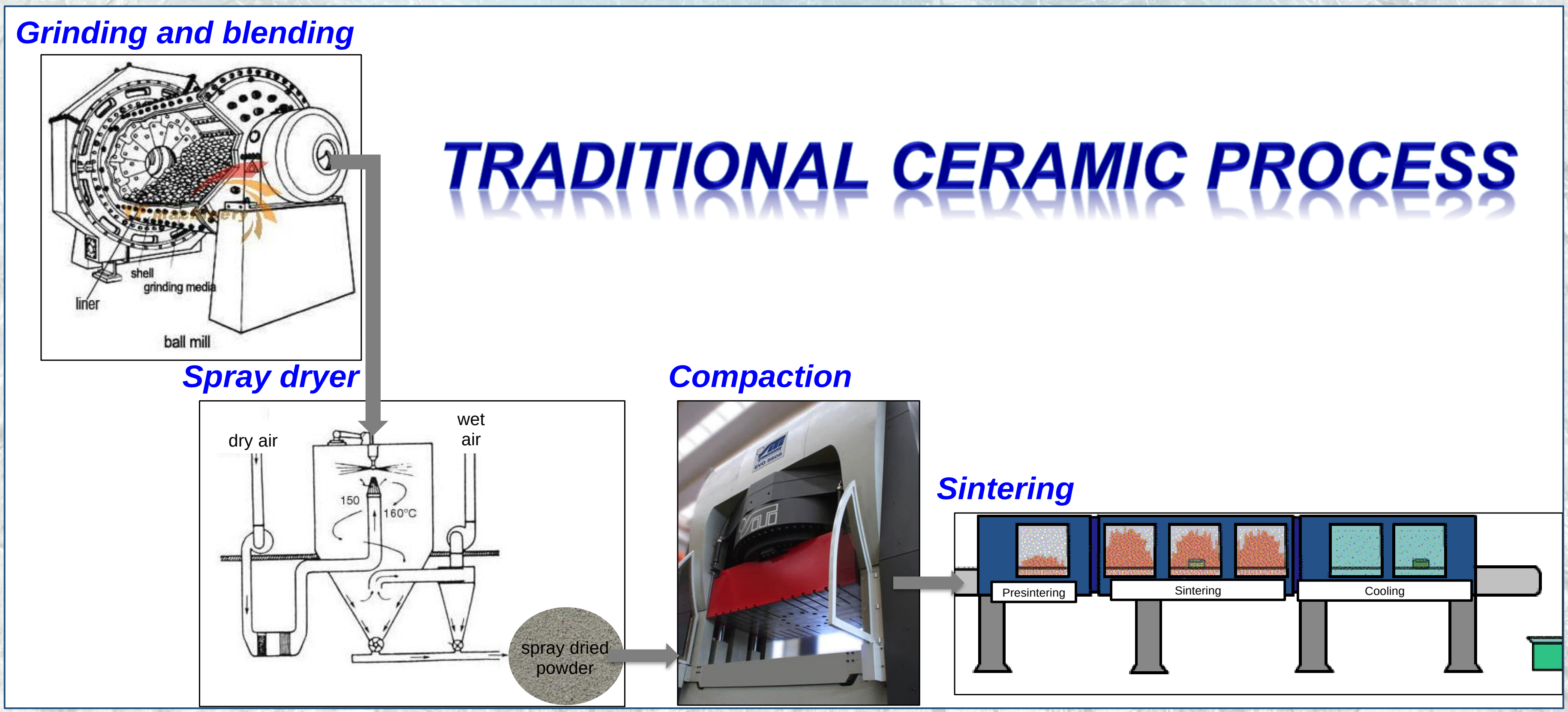
What we need to make porous materials?

Glass or glass ceramic matrix + pore forming agent

How can we make it



Expected results

Technical aspects

- ✓ Products with an apparent density between **0.4 and 1.2 g/cm^3**
- ✓ Products with thermal conductivity variable between **0.16 and 0.21 W / m K**
- ✓ Products with compression strength of **at least 2.7 MPa**.

Expected results

Environmental aspects

The products will:

- ✓ be much safer for health than rock fiber or glass fiber panels,
- ✓ be completely recyclable at the end of their useful life, by simple grinding and reintroduction into the production cycle;
- ✓ lead to a significant reduction of solid waste products because eventual waste could be reused;
- ✓ low consume of energy.

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Innovation:

An innovative aspect is the use of the **spacers method:**
admixing NaCl or appropriate **salts** to the atomized powders in order to create a percolating dispersion of such salts, which remain almost unaltered during the reactive oversintering of the surrounding material.

The main innovation of the project is the possibility to obtain expanded building materials, with outstanding insulating properties, using solely waste, or, in the case of interconnected open porosity, up to **90% waste materials**

Regarding the proposed product and process, the operating temperatures are highly lower than those in the current area.

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Sources of waste powders

Glass matrix

Glass cullet

Pore foaming agent

Marble waste ($CaCO_3$)

foaming agent

Salt

temporary space holder

Tire and Mechanical carbon (SiC and C)

foaming by reaction

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Sources of waste powders

Glass Cullet

Marble waste

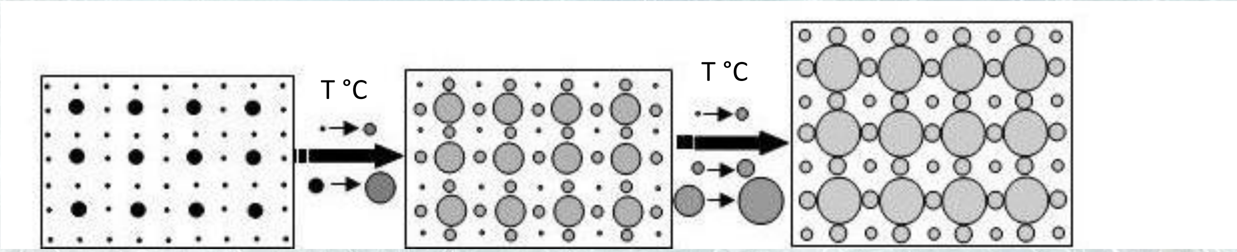
2009 - 2 million Ton. of glass cullet coming from glass packing in Italy.

2003 - 56 million Ton. of marble wastes produced in the world.

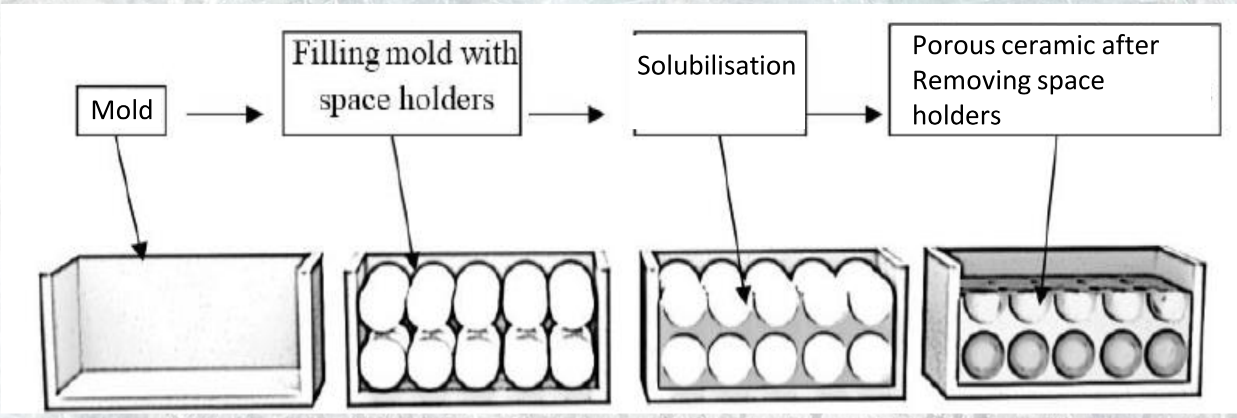
Experimental part: traditional production

How cellular ceramics were made

Method 1. Foaming agent



Method 2. Space holder method



Experimental part: traditional production

The three families of mixtures, were identified:

1. Mamma Rosa's Spray dry (61.5 wt%), recycling glass (15,4 wt%) and NaCl (23.1 wt%)

2. Spray dry (80 wt%) and recycling glass (20 wt%) pressed and no pressed

3. Spray dry(78 wt%), recycling glass (20 wt%) and **$CaCO_3$** (2 wt%)

$CaCO_3$ is provided by Ceramica Alta and obtained as a waste product by bubbling CO_2 into a $Ca(OH)_2$ aqueous solution to reduce furnace emissions (***LIFE+ project LIFE ZEF-tile***)

Salt

+

Mamma Rosa's Spray dry+ Waste Glass

MIXTURE

UNIAXIAL-PRESS FORMING

SINTERING@850°C

SINTERED GLASSCERAMICS/salt

HOT WATER

POROUS MATERIALS

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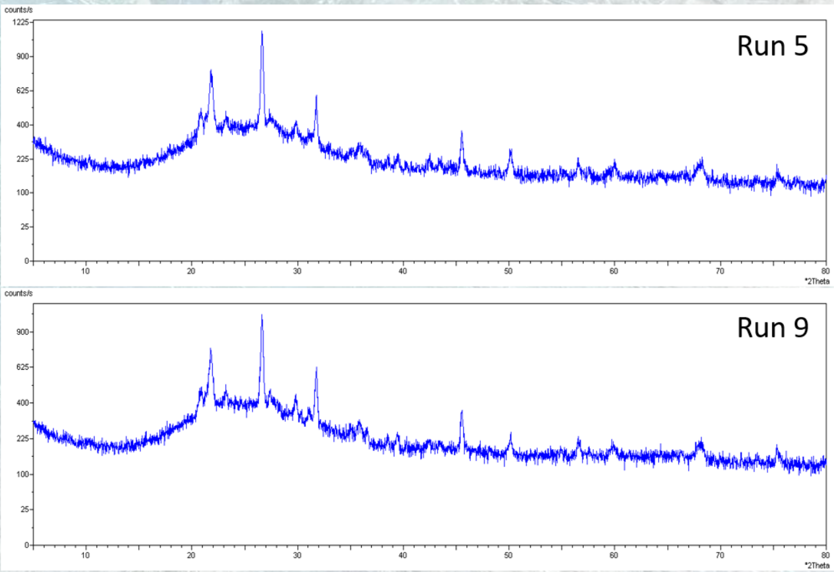
1. Mamma Rosa spray dry (61.5 wt%), recycling glass (15,4 wt%) and NaCl (23.1 wt%)

Apparent density

Run	Apparent density (g/cm^3) $\pm$ 0.01 g/cm^3
1	0.99
2	0.97
3	0.96
4	1.00
5	0.97
6	0.95
7	0.95
8	0.86
9	0.92
10	0.96
11	0.88
12	0.86



Phases: Quartz and NaCl

Apparent density required by the project 0.4 - 1.2 gr/cm^3

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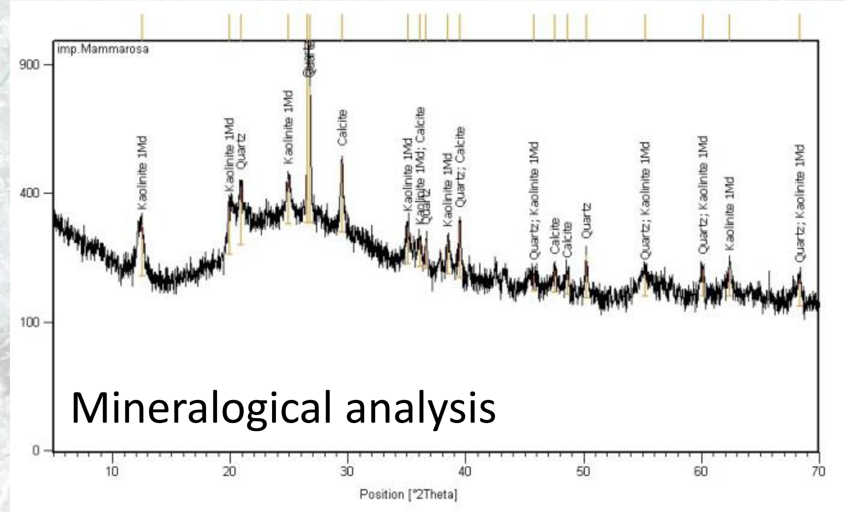
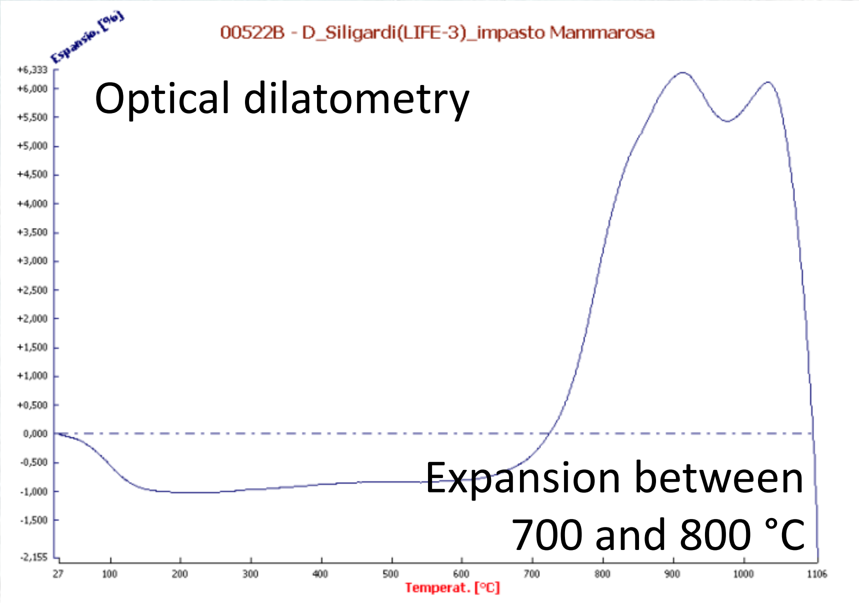
2. Spray dry (80wt%), recycling glass (20 wt%): pressed samples

3. Spray dry(78 wt%), recycling glass (20 wt%) and $CaCO_3$ (2 wt%) PRESSED





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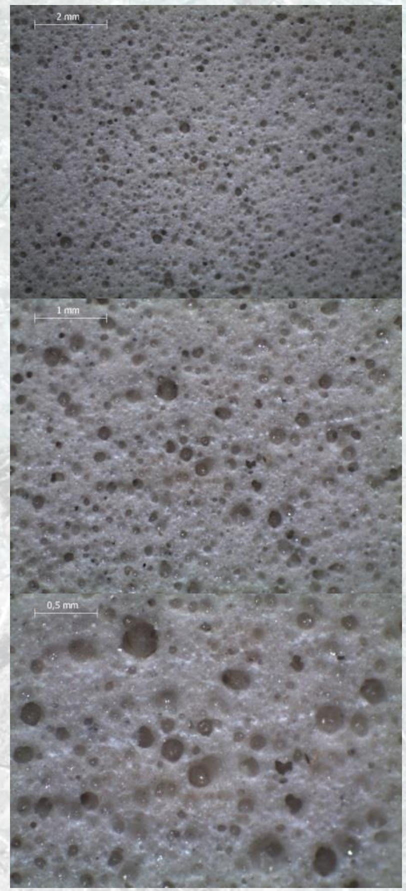
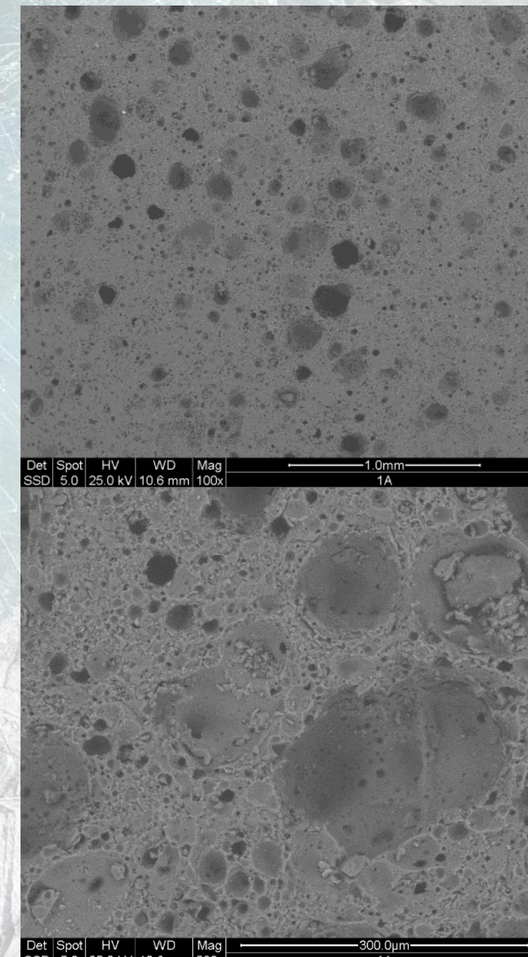
Sample 1: Mamma Rosa spray dry (80 wt%) and recycling glass (20 wt%)



Optical microscope pictures

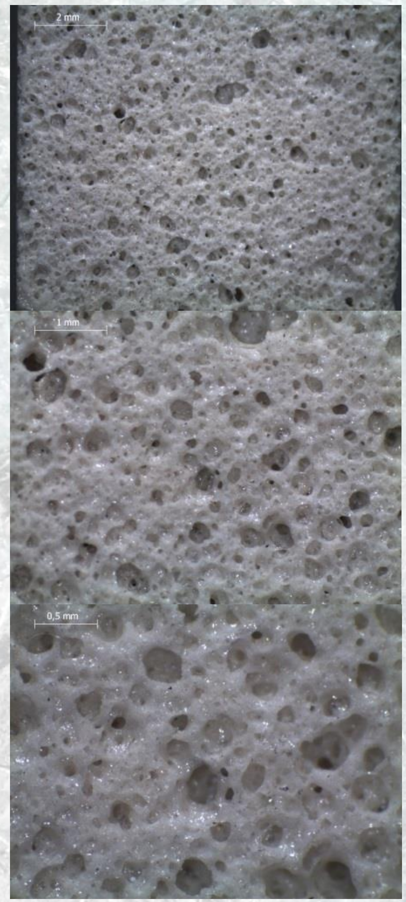
Sample	Apparent density (g/cm^3) $\pm$ 0.01 g/cm^3
1	1.22
2	0.74

Apparent density required by the project 0.4 - 1.2 gr/cm^3



SEM micrographs

Sample 2: Mamma Rosa spray dry (78 wt%), recycling glass (20 wt%) and $CaCO_3$ (2 wt%)

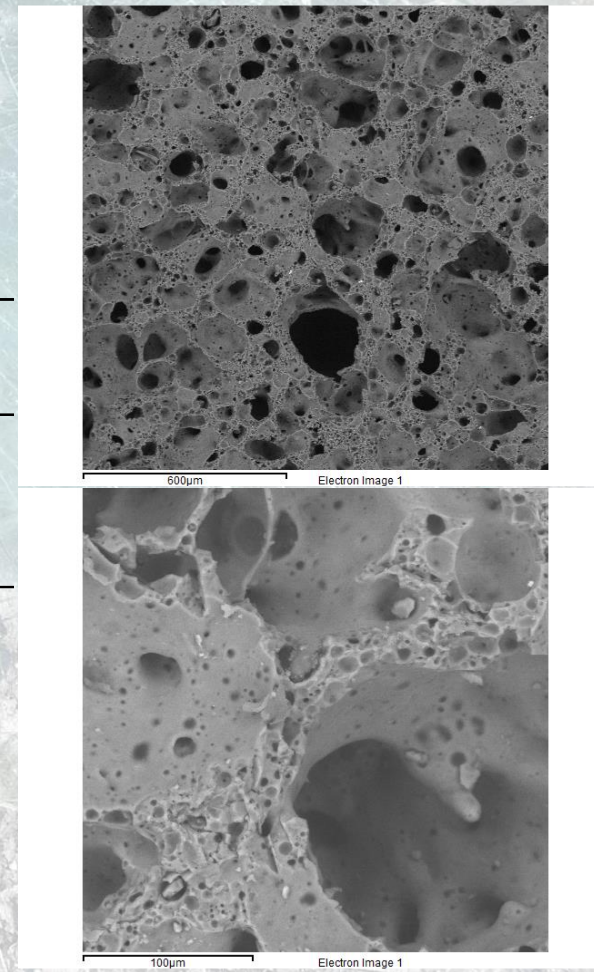


Optical microscope pictures

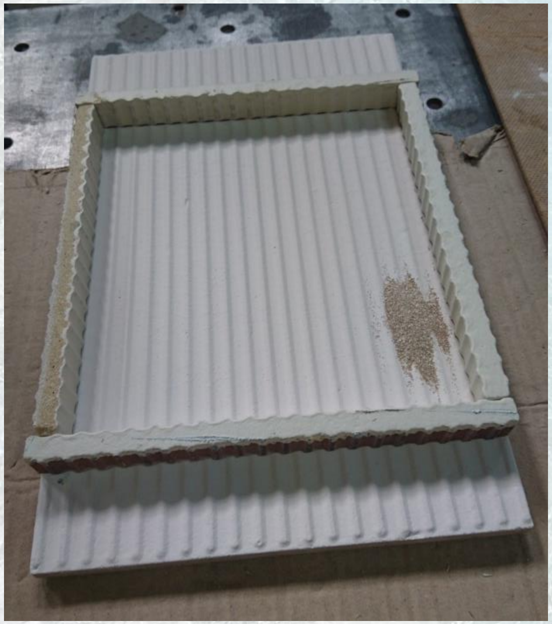
Sample	Apparent density (g/cm^3) + 0.01 g/cm^3
1	1.22
2	**0.74**

Apparent density required by the project 0.4 - 1.2 gr/cm^3

SEM micrographs



Industrial tests: NO pressed samples



Formulation investigated:
80 wt% spray dry – 20 wt% recycling glass

Heat treatment
- 45 min @ 780 °C
- 1h @ 780 °C
- 1h @ 800 °C

Engobed refractories moulds were used

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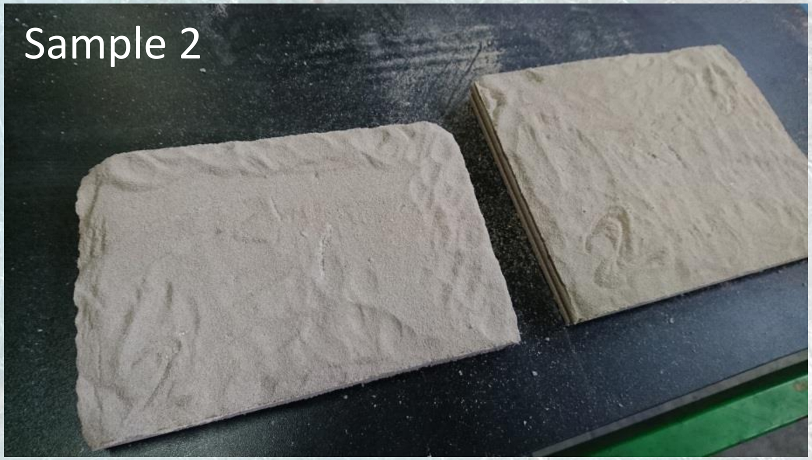
Industrial tests: non pressed samples



Sample	Heat treatment	Duration	Apparent density (g/cm^3)
1	780/790 °C	45’	0.66
2	Upper 750 °C Lower 780 °C	60’	0.66
3	**800 °C**	**60’**	**0.68**

Thermal conductivity sample #3: 0.16 W/m K

Industrial tests: non pressed samples

Heat treatment
- 1h @ 800 °C
- 1h @ 850 °C

Formulations
- 80 wt% spray dry - 20 wt% recycling glass
- 70 wt% spray dry - 30 wt% recycling glass

Industrial tests: non pressed samples

Heat treatment

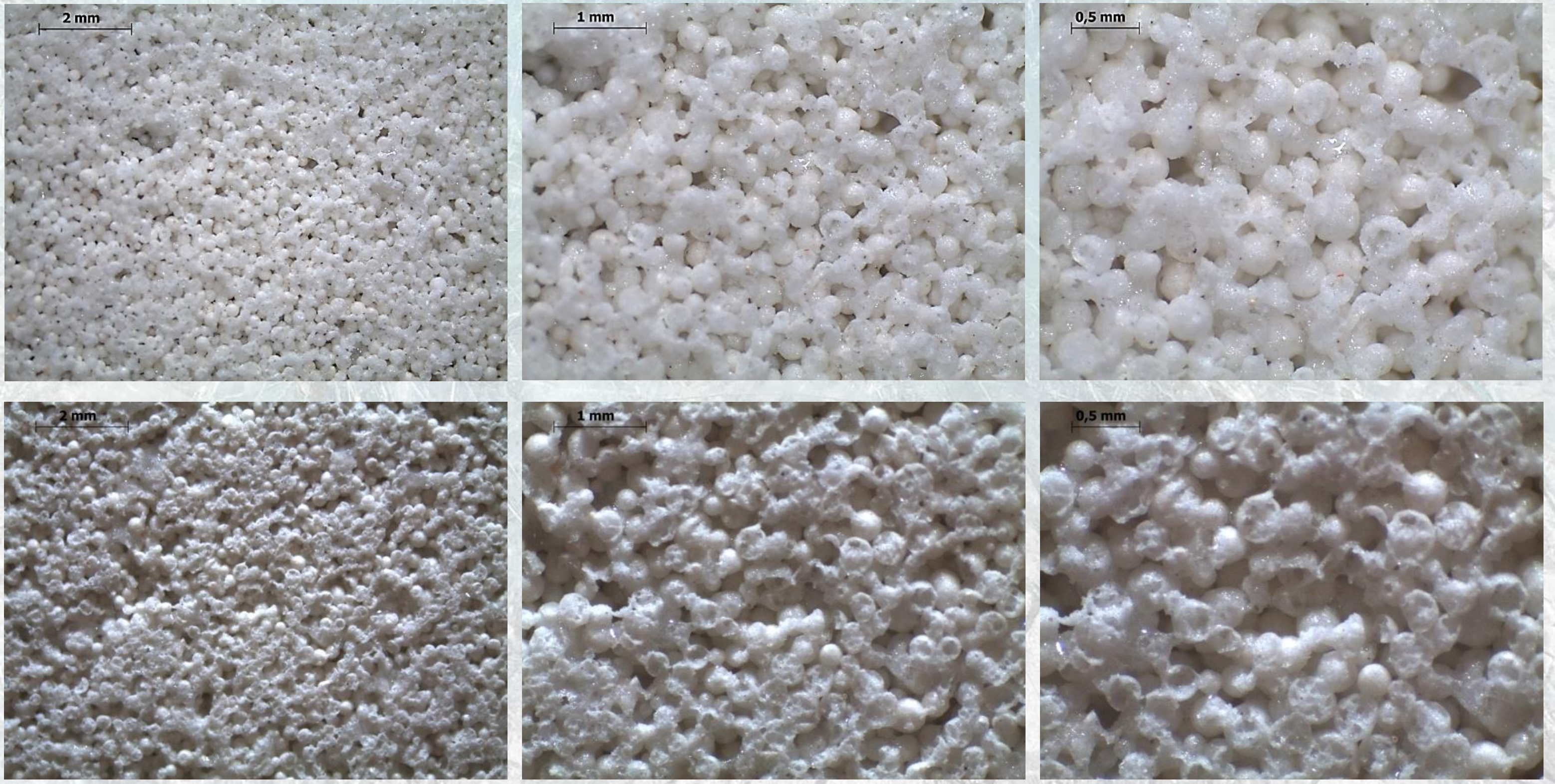
- 1h @ 800 °C
- 1h @ 850 °C

Formulations

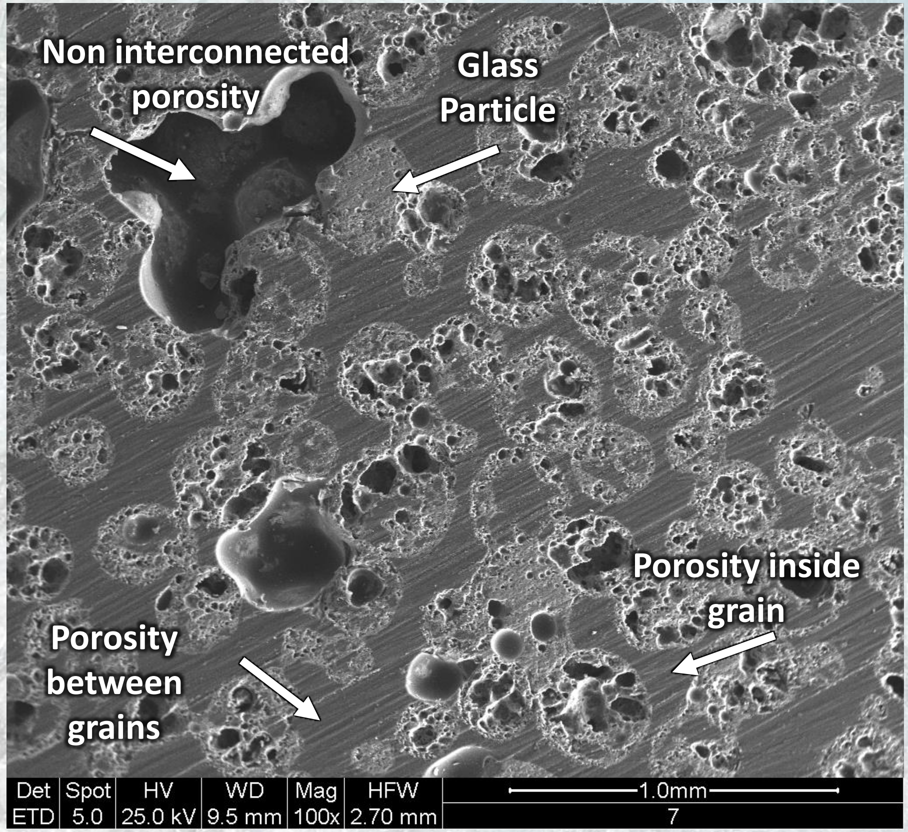
- 80 wt% spray dry - 20 wt% recycling glass
- 70 wt% spray dry - 30 wt% recycling glass

70/30
1h @ 850 °C

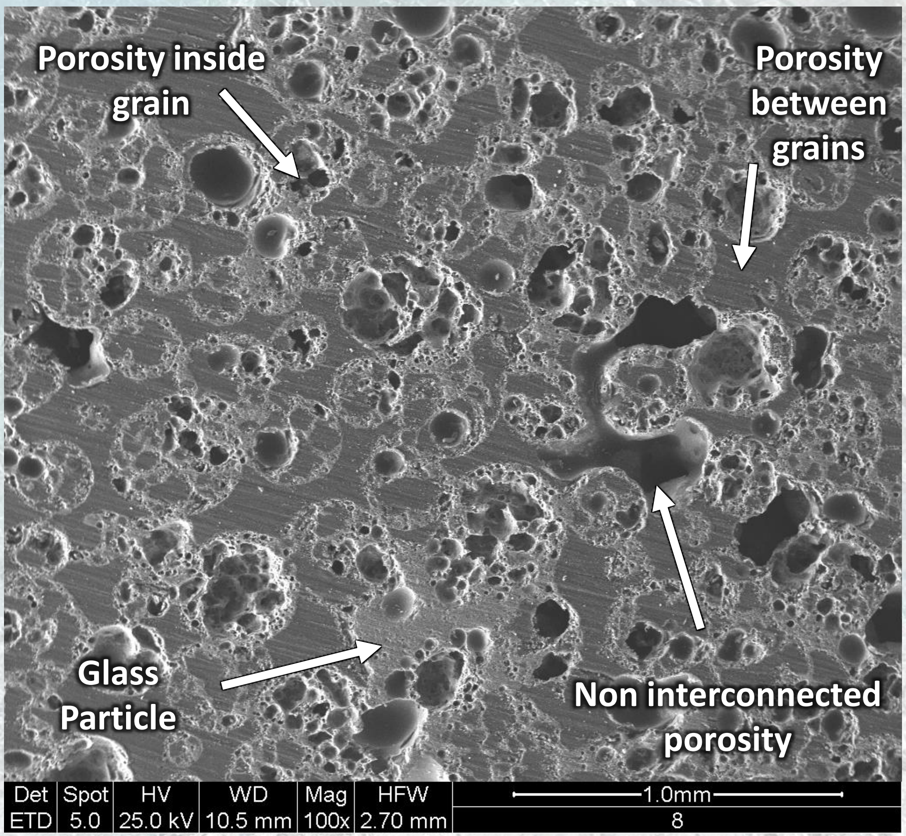
80/20
1h @ 850 °C



Industrial tests: non pressed samples



Sample 7



Sample 8

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Innovations

With regards to t[redacted]j[redacted]t requirement

☑ **Three different co[redacted]t[redacted]ns were identified**

☑ **Formulations of mixtures contain[redacted]a[redacted]least 90% of waste product (88.1**

☑ **Optimizatio[redacted]n[redacted]conditions**

Regardin[redacted]t[redacted]atment

☑ **low temperature [redacted]) (800 °C/ 850 °C)**

Technical requirements

☑ **Low weight (apparent density between 0.4 and 1.2 g/cm^3)**

☑ **Thermal insulation (thermal conductivity between .16 and 0.21 W / m K)**

☐ **Compression strength of at least 2.7 MPa.**

B5 LCA and environmental indicators – Sviluppo di uno studio di LCA di tipo semplificato e quantificazione degli indicatori ambientali di progetto- UNIPD

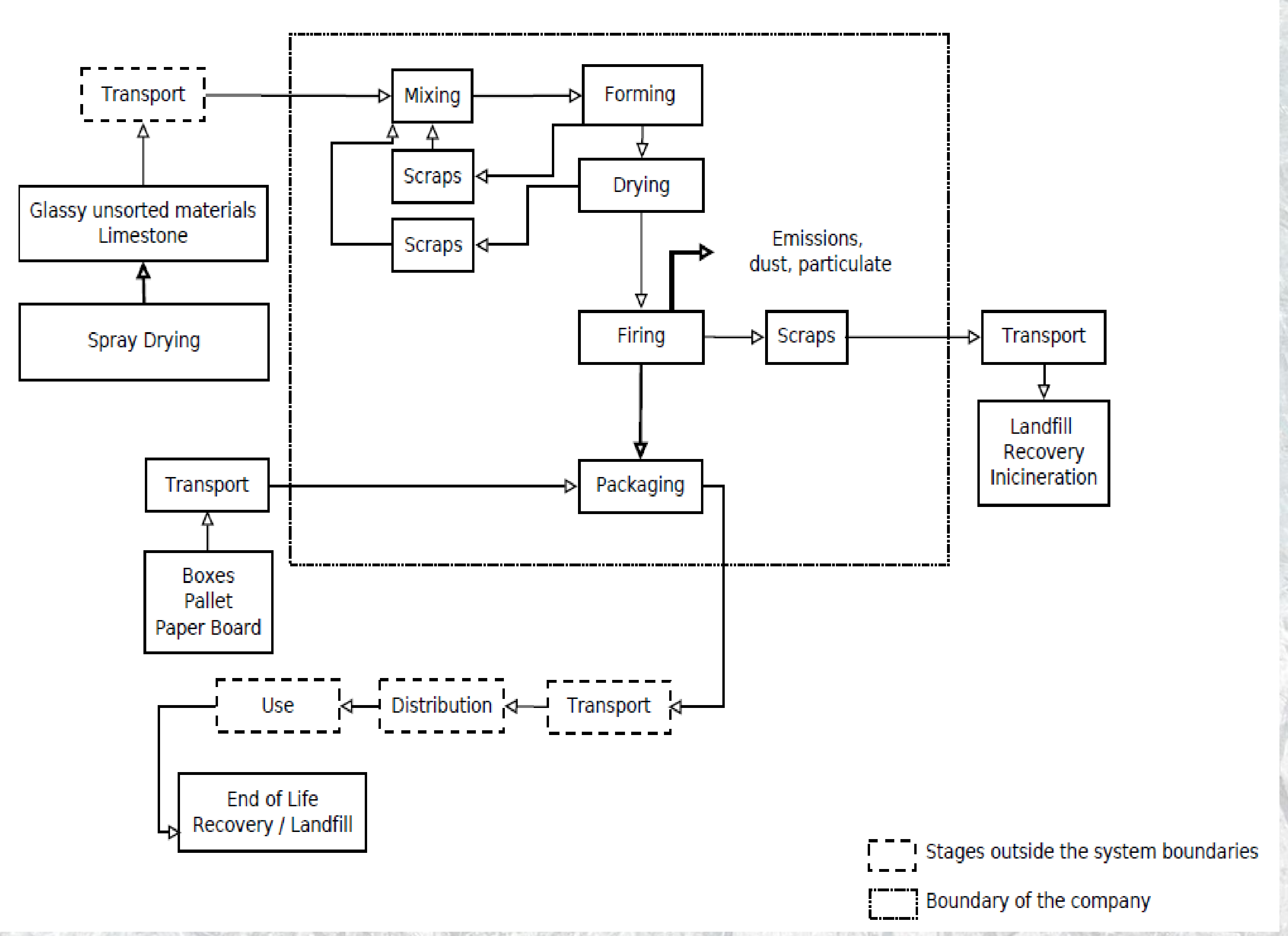
- Definizione dell'obiettivo e del campo di applicazione
- Analisi di Inventario
- Valutazione degli impatti
- Interpretazione

Le 4 fasi seguite per lo studio di streamlined LCA

L'Unità Funzionale considerata è un pannello di 1 m^2 (15 kg/m^2)

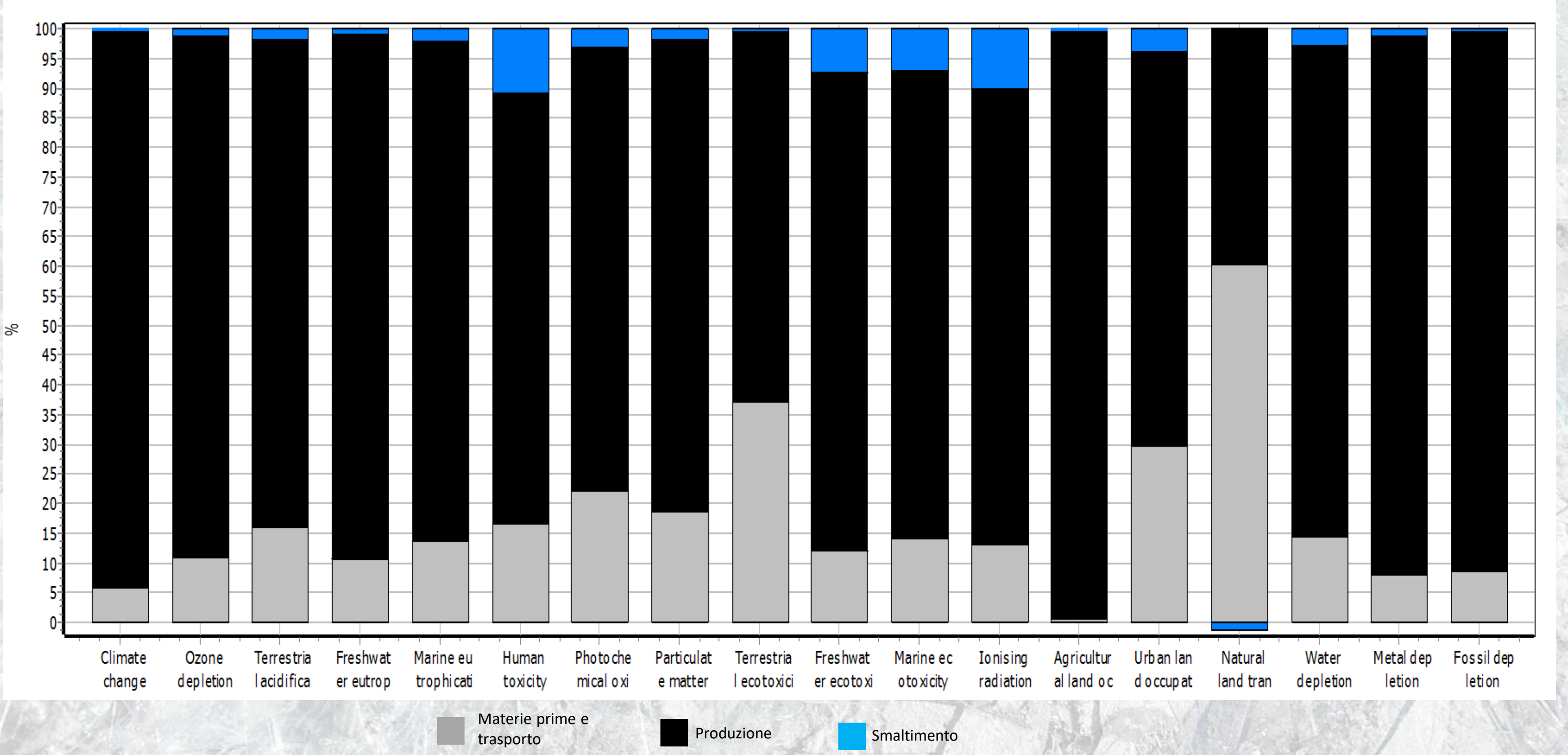
B5 LCA and environmental indicators

Sono stati definiti i confini del sistema da analizzare che comprendo le unità di processo presenti nella figura seguente **(macinazione, miscelazione, formatura, essicazione e cottura e imballaggio**):



B5 LCA and environmental indicators

Per le unità di processo individuate nella figura precedente sono stati raccolti dati e informazioni ed è stato elaborato il **modello di calcolo degli impatti ambientali**. Quindi sono stati calcolati i valori degli indicatori previsti dal metodo di valutazione ReCiPe 2008 e sono stati messi in **luce i principali contributi**, come riportato nella figura seguente.



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B5 LCA and environmental indicators

La fase che contribuisce maggiormente all'impatto è la fase di **produzione**. Per esempio per la categoria **Cambiamento Climatico** (Climate change) l'impatto è principalmente dovuto ai consumo di calore (per il 34%) e di energia elettrica (per il 18%). Il 33% è dovuto alle emissioni generate durante la fase di cottura.

Category	Unit	Total	Materie prime e trasporto	Produzione	Smaltimento
Climate change	kg CO2 eq	5,19E+00	3,04E-01	4,87E+00	1,63E-02
Ozone depletion	kg CFC-11 eq	4,89E-07	5,30E-08	4,29E-07	6,55E-09
Terrestrial acidification	kg SO2 eq	9,38E-03	1,50E-03	7,71E-03	1,63E-04
Freshwater eutrophication	kg P eq	6,20E-04	6,65E-05	5,47E-04	6,86E-06
Marine eutrophication	kg N eq	5,78E-04	7,87E-05	4,88E-04	1,16E-05
Human toxicity	kg 1,4-DB eq	6,26E-01	1,04E-01	4,53E-01	6,87E-02
Photochemical oxidant formation	kg NMVOC	8,51E-03	1,89E-03	6,36E-03	2,64E-04
Particulate matter formation	kg PM10 eq	3,93E-03	7,34E-04	3,13E-03	7,18E-05
Terrestrial ecotoxicity	kg 1,4-DB eq	2,95E-04	1,09E-04	1,85E-04	1,66E-06
Freshwater ecotoxicity	kg 1,4-DB eq	2,74E-02	3,27E-03	2,21E-02	2,03E-03
Marine ecotoxicity	kg 1,4-DB eq	2,60E-02	3,65E-03	2,05E-02	1,86E-03
Ionising radiation	kBq U235 eq	2,95E-01	3,91E-02	2,26E-01	3,00E-02
Agricultural land occupation	m2a	2,61E+00	1,38E-02	2,59E+00	8,10E-03
Urban land occupation	m2a	5,86E-02	1,74E-02	3,88E-02	2,41E-03
Natural land transformation	m2	2,15E-03	1,31E-03	8,66E-04	-2,84E-05
Water depletion	m3	2,85E-02	4,10E-03	2,36E-02	8,23E-04
Metal depletion	kg Fe eq	1,35E-01	1,08E-02	1,23E-01	1,78E-03
Fossil depletion	kg oil eq	1,20E+00	1,05E-01	1,09E+00	6,72E-03

B5 LCA and environmental indicators

All'interno delle attività di progetto è stato inoltre effettuato un confronto del **prodotto LIFE** con un materiale alternativo, **FOAMGLASS**, attraverso l'acquisizione di dati di letteratura. Tale azione ha rilevato che gli impatti associati al prodotto LIFE sono **significativamente inferiori** al materiale FOAMGLASS per quasi tutte le categorie analizzate. E 'importante sottolineare che il confronto è una prima analisi che non ha la funzione scientifica-divulgativa di un risultato assoluto ed è stato sviluppato attraverso **l'utilizzo di software e database diversi**, con la raccolta di dati primari e dati di letteratura.

Comparison between panel LIFE product and FOAMGLASS (CML-IA baseline – 1 kg)

Category	Unit	Total FOAMGLASS	Total LIFE product	Difference [%]
Abiotic depletion	kg Sb eq	7,05E-06	2,01E-07	-97%
Abiotic depletion (fossil fuels)	MJ	2,01E+01	3,68E+00	-82%
Global warming (GWP100a)	kg CO2 eq	1,33E+00	3,46E-01	-74%
Ozone layer depletion (ODP)	kg CFC-11 eq	1,79E-11	3,26E-08	Impact of LIFE product is significantly higher than FOAMGLASS
Photochemical oxidation	kg C2H4 eq	2,32E-04	4,18E-05	-82%
Acidification	kg SO2 eq	3,00E-03	6,71E-04	-78%
Eutrophication	kg PO4--- eq	3,70E-04	1,95E-04	-47%

Comparison between panel LIFE product and FOAMGLASS (Energy and CED – 1 kg of FOAMGLASS)

Category	Unit	Total FOAMGLASS	Total LIFE product	Difference [%]
Total use of renewable primary energy resources	MJ	9,01E+00	1,12E+00	-88%
Total use of non-renewable primary energy resources	MJ	2,06E+01	3,97E+00	-81%

Dissemination

☑ **Welcome to the Life Programme @ DII - UniPd 23/05/2015**

☑ **X INSTM Conference @ Favignana (TP) 28/06 - 01/07/2015**

☑ **EuroMat @ Warsaw, Poland - 20 - 24/09/2015**

☑ **3° seminario LCA @ UniMoRe - DISMI 29/09/2016**

☑ **Life+ day @ UniMoRe - DIEF 19/01/2017**

☑ **ECERS 2017 @ Budapest 19 - 23/07/2017**

Coordinator

Mamma Rosa's- Fabio Raimondi

Partners

Ceramica Fondovalle- Vito Remigio

UNIMORE- Cristina Siligardi

UNIPD- Marco Mason

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http://ec.europa.eu/environment/life/index.htm

Si ringrazia la direzione e tutto il personale di ELLE3 - Modena - p
il supporto nella formazione del parternariato, nella stesura,
gestione e rendicontazione del progetto

http://www.elle3.it

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