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“A team of engineers, consultants, designers, planners and specialists supporting Clients from concept to decommissioning, through consultancy, design, management and operation & maintenance engineering”

Part of RINA Group, headquartered in Genoa with more than 20 offices around the world

Employees (2015): 1300 units

Revenue (2015): 128 million of €uros

Four Business Units:
- Industry & Power Generation
- Oil & Gas
- Environment & Sustainability
- Transport & Infrastructure
The Project LEEMA (Low Embodied Energy Advanced (Novel) Insulation Materials and Insulating Masonry Components for Energy Efficient Buildings), is a co-funded project by the 7th Framework Program of the European Community (FP7-2011-NMP-ENV-ENERGY-ICT-EeB No. 285059). It lasted 48 months with a budget of more than 8 million of euros.

The LEEMA main objective is to develop novel, inorganic insulation materials and building insulation masonry components with low EMBODIED ENERGY and good technical and environmental performance.

The new products are called “3I” as they are Inorganic, Insulating and Incombustible.

The project is coordinated by S&B Industrial Mineral S.A. with the participation of 13 European Partners.
A detailed **Life-Cycle Analysis** has been performed by D’Appolonia to assess the environmental impact related to **the innovative 3I products**, compared to **the most widely applied insulation materials**, aiming to demonstrate the energy benefits and the environmental sustainability of the proposed innovative insulation products.

The system has been divided into:
- **Background system**, which have not been inventoried with actual data from suppliers, but included and evaluated on the basis of data taken from dedicated databases (*GaBi Professional Database and Ecoinvent v 2.2*).
- **Foreground system**, which have been instead inventoried, based on data from the owners of the technologies.

Information about the manufacturing process of the products have been provided by SandB, Etex, SCHLAG, Tceram, Morando, FIBRAN. Assistance in calculating the embodied energy of various 3I products has been provided by NTUA. The dedicated **software GaBi 6** has been used for the analysis.
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3I Loose fill materials for cavity walls</td>
<td>SandB</td>
<td>Cellfill process</td>
<td>LF.1</td>
<td>Cellfill</td>
<td>New process, involving IR expansion - Already implemented at lab and pilot scale</td>
<td>LT.1_INNO</td>
<td>LF.1_INNO</td>
<td>3I Loose-filling - cavity walls</td>
</tr>
<tr>
<td>Loose Fill materials as raw material in other LEEMA products</td>
<td>Implemented in ETEX new production process</td>
<td>Expanded perlite (raw perlite expanded by ETEX, SCHLAG, TcERAM)</td>
<td>N.P.</td>
<td>Expanded perlite used in production</td>
<td>NTUA-S&amp;B</td>
<td>LF.2_INNO</td>
<td>Loose-filling for FC BOARDS (ETEX)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ex-Tceram</td>
<td>Cement binder for FC boards (Hatschek)</td>
<td>N.P.</td>
<td>Cement</td>
<td>NTUA - Morando</td>
<td>LF.3_INNO</td>
<td>Loose-filling for EPBs (ex-Tceram) and Bricks &amp;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Implemented in SCHLAG new production process</td>
<td>Clay bricks</td>
<td>N.P.</td>
<td>Clay</td>
<td>Same as SOTA - Replace expanded perlite or vermiculite with LF.2_INNO as raw material</td>
<td>B1.1_INNO</td>
<td>3I Binder 1 (includes LF.2_INNO)</td>
<td></td>
</tr>
<tr>
<td>3I FC boards</td>
<td>ETEX</td>
<td>Hatschek</td>
<td>B1.1</td>
<td>Promatec-H (inclusion of Perlite expanded in Etex plant - impact higher than standar perlite)</td>
<td>ETEX</td>
<td>B1.4_INNO</td>
<td>3I FC Boards 2 (includes LF.2_INNO AND 3I Binder 1)</td>
<td></td>
</tr>
<tr>
<td>3I EPBs</td>
<td>Fibran</td>
<td>Fourdriner</td>
<td>B2.1</td>
<td>Fesco board</td>
<td>NTUA - Morando</td>
<td>B2.1_INNO</td>
<td>3I EPB (includes LF.3_INNO)</td>
<td></td>
</tr>
<tr>
<td>3I Foamed Blocks</td>
<td>Fibran</td>
<td>Aerated concrete process</td>
<td>B3.1</td>
<td>Aerated concrete (from Ecoinvent)</td>
<td>NTUA - FIBRAN</td>
<td>B3.1_INNO</td>
<td>3I foamed blocks</td>
<td></td>
</tr>
<tr>
<td>3I Bricks and Facades</td>
<td>SCHLAG</td>
<td>Perlite filled bricks production</td>
<td>BR.1</td>
<td>Poroton-T7 (inclusion of Perlite expanded in SCHLAG plant - impact higher than standar perlite)</td>
<td>SCHLAG</td>
<td>BR.1_INNO</td>
<td>3I Bricks 1 (includes LF.3_INNO)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>FC.1</td>
<td>WDF (inclusion of Perlite expanded in SCHLAG plant - impact higher than standar perlite)</td>
<td>FC.1_INNO</td>
<td>FC.1_INNO</td>
<td>3I Facades 1 (includes LF.3_INNO)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NTUA - Morando</td>
<td>Adapted brick production process</td>
<td>BR.2_INNO</td>
<td>3I Bricks 2 (includes LF.3_INNO and 3I Binder 2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LEEMA PRODUCTS**

Products analyzed
The goal of the analysis is to assess the environmental impacts of five different product categories*:

- Loose Filling Materials
- Fibre Cement Boards
- Insulating Bricks & Façades
- Expanded Perlite Boards
- Foam Blocks

- The cradle to gate story of all products is considered, from raw materials extraction through production of intermediates, finishing and packing operations.

- Service life for all the solutions (SoA and Inno) has been fixed at **20 years**.

- The production processes of Innovative products, developed at lab and then pilot scale, have been [industrial upscaled](#) though a critical analysis of equipment done by NTUA, Morando and D’Appolonia.

*For each product category there is one (or more) SoA version and one (or more) innovative version (Inno), developed across the project.
The functional unit has been chosen based on mass and thermal values of different products, in order to provide an effective comparison between SOA and INNO products (when available).

Therefore, two different FU have been selected depending on the various cases:

- Same thermal insulation $\Rightarrow$ R value $= 1$ m$^2$K/W
- Same weight $\Rightarrow$ Mass $= 1$ kg of product

The first option takes into account the increased insulation performances of LEEMA Products, while the second one has been used for products just prototyped, whose thermal properties have not been measured, or for products where insulation properties are secondary compared to structural ones.
## Innovative products

<table>
<thead>
<tr>
<th>Company</th>
<th>Comparison</th>
<th>Selected FU</th>
<th>Considered amounts for the comparison</th>
</tr>
</thead>
</table>
| ETEX    | B1.1 vs B1.1_INNO | 1 m² of product providing an R-value of 1 m² K/W | B1.1: 164 kg/m²  
B1.1_INNO: 147 kg/m² |
|         | B1.1 vs B1.4_INNO | 1 kg of product |  
B1.1: 1 kg  
B1.1_INNO: 1 kg |
| SCHLAG  | BR.1 vs BR.1_INNO | 1 m² of product providing an R-value of 1 m² K/W |  
BR.1: 40 kg/m²  
BR.1_INNO: 38 kg/m² |
|         | BR.1 vs BR.2_INNO | 1 kg of product |  
BR.1: 1 kg  
BR.2_INNO: 1 kg |
|         | FC.1 vs FC.1_INNO | 1 m² of product providing an R-value of 1 m² K/W |  
FC.1: 25 kg/m²  
FC.1_INNO: 23 kg/m² |
|         | FC.1 vs FC.2_INNO | 1 kg of product |  
FC.1: 1 kg  
FC.2_INNO: 1 kg |
| S&B     | LF.1 vs LF.1_INNO | 1 m² of product providing an R-value of 1 m² K/W |  
LF.1: 5,659 kg/m²  
LF.1_INNO: 2,315 kg/m² |
|         | Exp perlite ETEX vs LF.2_INNO | 1 m² of product providing an R-value of 1 m² K/W |  
Exp perlite ETEX: 4,872 kg/m²  
LF.2_INNO: 3,928 kg/m² |
|         | Exp perlite SCHLAG vs LF.3_INNO_VEF |  |  
Exp perlite SCHLAG: 2,05 kg/m²  
LF.3_INNO_IR/VEF: 1,528 kg/m² |
| T-CERAM | B2.1 vs B2.1_INNO | 1 m² of product providing an R-value of 1 m² K/W |  
B2.1: 8,46 kg/m²  
B2.1_INNO: 19,61 kg/m² |
| FIBRAN  | B3.1 vs B3.1_INNO | 1 kg of product |  
B3.1: 1 kg  
B3.1_INNO: 1 kg |
3I Products

The main outcomes of the LEEMA project are materials from perlite waste and are represented by new generation of **Loose Filling Materials** (LFM), in substitution of common expanded perlite, and **Geopolymeric Binders**, in substitution of cement and clay.
Five product categories have been analyzed within LEEMA project framework by Schlagmann, i.e. one standard **brick** and one SoA **façade** and their two innovative versions: one containing the 3I Loose Filling materials, the other one containing also the 3I binder, in replacement of the clay brick body.

Innovative **expanded perlite boards** (EPB) has been compared with Fesco boards.

Innovative **Fibre cement (FC) boards** have been compared with Etex Redco Compact Boards.

The Aerated concrete block has been selected as standard product to which the innovative **foamed block**, manufactured by Fibran, has to be compared.
Gross Energy Requirement (GER)
(Primary Energy Demand from renewable and not renewable resources - gross calorific value)
Life Cycle Impact Assessment

Global Warming Potential (GWP)

**LFM for cavity walls**
- 10%

**LFM for Fibre Boards**
- 65%

**LFM for Bricks/Façades**
- 28%
- 63%

**Fibre Cement Boards**
- 17%

**Fibre Cement Board with 3I Binder**
- 51%

**Bricks with LFM**
- 23%

**Bricks with LFM and Geopolymeric Binder**
- 24%

**EPB**
+12%

**Foam Block**
- 58%

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Results Interpretation

In order to provide a more comprehensible outlook of results, a *Results Aggregation Procedure (empiric)* is proposed, to give a unique indication for each new product developed (compared to respective benchmark).

Six indicators evaluated: EE, GWP, EP, OP, RD, WD and a medium variation value (%) has been calculated for each comparison.
Conclusions

✓ Innovative Products present **good results** compared to correspondent standard products, in particular the LFM for cavity walls.

✓ The only exception is the EPBs, where no positive results are obtained, signal of the need of further R&D work.

✓ The results indicate that the introduction of LEEMA products gives the possibility to reduce the embodied energy up to **65%** and the carbon footprint up to **65%**, compared to traditional materials for the same application.

✓ The new products can introduce a “**greener**” solution to the market, with significantly reduced environmental impacts, up to **60%**, taking into account key indicators like Primary Energy Demand, Global Warming Potential, Eutrophication Potential, Ozone Depletion, Resource Depletion and Water Demand.