PROJECT NUMBER
LIFE07 ENV/IT/000361

FINAL REPORT
Covering the project activities from 01/01/2009 to 31/05/2012

Reporting Date
23/10/2012

LIFE+ PROJECT

No Vetro in Discarica: demonstrating innovative technologies for integral recovery of glass rejects actually landfilled

(NOVEDI)

Data Project

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<td>30/06/2011 Extension date: 31/05/2012</td>
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<td>(%) of eligible costs</td>
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Data Beneficiary

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<th>Sasil S.p.A.</th>
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<td><a href="http://www.sasil-life.com">www.sasil-life.com</a></td>
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1. List of keywords and abbreviations used

CP:  Common Provisions
CC:  Coordination Committe
MF:  Monitor lead special glass (CRT) front side
MR:  Monitor lead special glass (CRT) back side
BL:  Glass from lamps
VA:  Artistic glass
MS:  Mosaic glass
FN:  New glass for fibre
FT:  Old glass for fibre
Rifer: Soda Lime container glass Italian production average analysis
VV:  SASIL glassy sand recovered from rejected cullet (before land-filled)
SC:  Slag from solid waste incinerators (used as additive)
FF:  Glass recovered from furnace draining
2. Executive summary

Objectives

The NOVEDI project, ‘No vetro in discarica: demonstrating innovative technologies for integral recovery of glass rejects actually landfilled’, has been carried out by Sasil SpA and its partner Province of Biella, starting from April 2009 until May 2012. It was co-financed by the LIFE programme under n° LIFE07 ENV/IT/361.

Main project objective was to demonstrate the feasibility to reduce to zero the glass rejects that do not come from cities’ collections and that, due to their particular chemical compositions can not be recycled, neither by glass container nor by ceramic industry. Examples are television screens, mosaic and artistic glass, PVB containing glass from the car industry, glass textile sheets, glass of lamps. These glass rejects are actually landfilled. The project aimed to demonstrate new technologies which allow their use in the production of glass based insulation materials with a high performance in thermal insulation, mechanical strength, fireproof and eco-compatibility, which traditional production is too expensive for a large market introduction. It aimed as well to foster future market introduction by sensitizing on energy efficient building.

The specific objectives can be summarised as follows:
1.- demonstrate the possibility to reduce to zero the land-filling of increasing amounts of special glass rejects which represent a high threat level to the environment containing lead, fluorine, etc..
2.- allow the wider introduction on market scale of glass based insulation materials, by producing them from actually unrecyclable glass rejects and thus reducing their price. This material has a performance in resistance, safety and reversibility which is much higher than the commonly used polyurethane, insulation material which requires scarce petroleum resources.
3.- make Italian construction sector and citizens familiar with eco-compatible construction materials aimed at reducing energy use, in particular with glass-based insulation materials, as to assure sufficient demand for recycling of all glass rejects actually landfilled in North Italy.

Activities and results

Action n°1 featured, with scientific support of the Department of Material Engineering at Padua University, the characterisation of five different types of special glass waste (TV monitor and PC display glass, glass of lamps, mosaics glass, stained glass, fiber glass) that, due to their chemical composition, are not suitable for use in the glass industry and therefore are generally vested in landfill. Analyses concerned chemical composition of the glass rejects; physical properties of grinded classic soda lime glass and the same mixed with special glass rejects; elements emitted by each special glass when heated up for foamed glasses formation; tests on ionic desorption in water of selected waste glasses.

These analyses offered the technical guidance for the pre-treatment of the special glass rejects, aimed at their use in the mixtures to be foamed. The characterization permitted to identify some basic parameters for the correct behaviour of the most suitable mixtures for foaming (particle size, reactivity, fusibility, stability during heating, ionic desorption, ...). Two deliverables and a test report where produced.

Action n° 2, concerned the production of starting- glass. Confirmations concerning all the technologies for a proper preparation of starting glass powders has been achieved and they have been tested in glass foams production with satisfactory reproducibility.
The technologies have been defined on the basis of Action 1 outcomes, adapting a series of original physical treatments actually employed within SASIL for natural mineral and soda lime glass treatments. The treatment cycle foresees the removal of inorganic non glassy materials with floating techniques, non magnetic metals by a metal detector and iron by an appropriate magnetic system. Then some of the special glasses have to be washed with water to remove the water soluble organics compound that, due to their strong reducing effect, can give problems during the foams formation. Each special glass, after the above described treatments, has to be dried and then grounded with a high pressure roller mill obtaining a glass powder which, for 100%, must have a size lower than 300 microns.

At the end of action 2 (Preparation of starting glasses), a specific study aimed to assess the economic compatibility with the conventional foaming process (use of classic soda lime glass) has been made. The achieved results, reported in the Deliverable “Justification of the economic compatibility” show that the overall costs of the preparation, taking into account both the negative prices of each special glass (saving of land-fill cost) and non technological compliances, thanks to the stability of all the special glasses against the hydrolytic attacks and to the absence of pollutants substances leaving the foaming furnace, are lower than the conventional foaming of classic soda lime glasses alone.

The action has been completed for its experimental part within the set time (2009), while during the first half of 2010, the production of 150 ton of starting-glass for the construction of the demonstration building was completed.

Action n° 3, concerning the preparation of glass based cellular materials on laboratory scale, started in advance, and has been completed on time (end of March 2010). The first flash trials done in discontinuous at Padua University, have been repeated, confirmed and completed at the SASIL plant laboratory from July 2009 to March 2010 exploiting the new continuous laboratory furnace acquired by SASIL.

The results achieved in the complete series of tests allowed, on the one hand, to set up both heating and cooling timing to be applied on the pilot plant trials (action 4) and, on the other hand, to obtain cellular materials with mechanical, physical and heat insulation properties good enough for the scope of our Project, as laid down in the Report “Physical Properties of the product”).

The last two months of Action 3 time schedule have been dedicated to assess the possibility to use rejects from waste soda lime glass treatment processes instead of normal soda lime glass waste. Within Sasil a Glassy Sand quality problem (MEIGLASS Project) had occurred, caused by the presence of some parts per million of non fusible materials heavier than glass. The problem has been successfully overcome but provoked a small amount of soda lime glass rejects, which cannot be used for Glassy Sand (for glass container industry). This material now substitutes the soda lime glass waste used in the NOVEDI mixtures, achieving a 100 % actually unrecyclable glass composition of the blends.

The results evaluation, for glass mixtures foamed both in discontinuous and in continuous conditions using the new laboratory device, has been done by assessing the micro-pores dimensions and their homogeneity dispersions in the foam mass. The results of continuous foaming confirmed the discontinuous ones and were feasible for programming the pilot plant systematic trials. The activity was continued during the pilot plant operation in spot form in support of this operation, in order to fine-tune the final product.

Action 4 concerned the construction and experimental operation of the pilot plant. The Pilot installation was ready by 30/07/2010 as foreseen, but revised as far as the breaking plant concerned, finalized in summer 2011.

The tests of Action 1, as well as the experimentations done in Action 3, allowed SASIL staff to define, earlier than foreseen, the technical specification of each device of the equipment to be
acquired. This permitted to have the pilot furnace delivered yet at the end of December 2009 and
the other accessory components of the pilot plant in January 2010. The plant has a production
capacity of 25,000 m³/year.
The plant was running experimentally until January 2011 with waste soda lime glass and
diversified additions of the various special glass rejects, in order to understand the behaviour and
confirm the data obtained in the lab environment. Results were positive, although the produced
materials performed some unforeseen limits, which brought 1) to decide to exclude rear monitor
glass rejects from the mixtures; 2) to change the breaking session of the plant and 3) to the
necessity to change some features of the demonstration building in Action 5. It resulted
necessary to foresee different functionalities of the crushing (or breaking) section in function of
different granularity requirements of the glass foam used in structural concrete for floor and roof,
and very light insulating concrete for the wall construction. The created plant was able to
produce the desired material for insulating concrete in granules or blocks, but for its employment
in lightened structural concrete, the breaking plant had to be redesigned and modified by
substituting part of its equipment.
Prof. Collepardi (ENCOSrl) was involved to assess which kind of improvements would be
necessary in order to achieve a lightened concrete with the correct mechanical properties.
Subsequently the breaking plant was modified.

While modifying the breaking plant, sufficient glass foam material has been produced to start the
building of the foundation of the demonstration building and to prepare for the construction of
the walls. The production of the material for the floors and roof was performed during the last
months of 2011, using the modified breaking plant.

**Action n° 5** foresaw the construction of a demonstrative building, made with foam glass
lightened concrete. In 2010 the terrain where to build the construction was prepared. The design
of the demonstration building had been prepared yet at project start, but underwent modifications
until spring 2011, due to comparison of the structural characteristics of the concrete to be
produced employing the new glass foams with the modified building legislation in recent years
regarding higher requisites to anti-seismic provisions. This led to the necessity to support bearing
walls with pillars and to further study of the preparation of structural concrete lightened with
glass foam for specific use in the floors and the particular roof construction and changing the
breaking plant (action 4).
Although the compliance of the special concrete to be employed was ascertained by engineering
company ENCO srl after many trials, it had to be certified by an EC recognized agency prior to
its employment. The fact that certification was obtained only by the end of March, delayed the
realisation of the building. By the end of May, side walls had been constructed as well as the 1st
floor’s slab. The remaining part of construction is being carried out after closure of the project.
Based on experiences with the floor construction, it appeared in July too risky to apply the
structural lightened concrete to the sloping part of the roof construction, as concrete jet on this
sloping surface would probably cause demixing. It was thereupon decided to construct this part
of the roof with wood and applying glass wool produced with bottom ash from incinerators,
developed in the VALIRE project. By end of September all glass foam based construction works
had been accomplished and it is expected to inaugurate the building in spring 2013.

For the construction of this building 80,000 kilo of recycled glass has been used to produce the
glass foam: 85 % soda lime glass rejects; 5 % front monitor glass rejects; 5% fiber glass rejects
and 5% of a mixture of lamp and artistic glass rejects. The created 400 m³ of foam glass has
been used as inert in the composition of lightweight structural concrete (density 1800 kg/m³) for
floors and horizontal part of the roof, and super-lightweight insulating concretes (density 1000
kg/m³) for the walls. It should be added that the building will be completed by an innovative big
arc in steel with a mobile high efficiency photovoltaic panel that is moving in two ways, rotation
and translation during the day in order to catch optimally the sun while giving shadow in summer. Lastly, the building will be totally energy-autonomous, is composed in total of 85% recycled materials and all glass foam materials used result from an LCE to be recyclable at end-of-life.

**Action n° 6** aimed at the Sensibilisation and dissemination of the results towards construction sector, citizens and public sector. Province of Biella was responsible for this action in which Sasil offered its support. The action was kicked off with the preparation of a Dissemination & Communication plan, networking activities with stakeholders of the building sector and subsequent feasibility study, concluded on 30/04/2010, to understand the best approach to be used to enhance energy efficient and eco-compatible building in its territory. It was yet clear at project start that the creation of an own financial support instrument, as proposed in the project, would not offer any added value to meanwhile improved national and regional schemes, but that lack of awareness and knowledge should be tackled. The ‘Analyses of use, degree of knowledge and informative needs of citizens, enterprises and local authorities’ was based on distributed questionnaires to citizens, enterprises and local authorities. Also a Vademecum was produced, directly satisfying part of the identified needs.

The results let to a huge sensibilisation and information campaign, in which the institution of a physical and online energy desk ([www.novedi.it](http://www.novedi.it)) formed the cornerstone. The entire stakeholders network collaborated in the activities, and the NOVEDI project functioned as the emblem for sensitizing target groups on the issues of building insulation and consequent energy savings, as well as the environmental value of recycling waste otherwise destined for landfill. The portal permitted the diffusion of the vademecum for citizens, as well as many other contents and possibility to ask for consulting services. In order to achieve a wider territorial impact, the Province of Biella organized 6 local meetings with citizens spread over its territory, and has been present at numerous local manifestations with a dedicated stand. In this context, Sasil has always been present to illustrate in detail the objectives of the NOVEDI project. With a view on financial sustainability, the physical desk has been taken over later by Confartigianato and CNA, buildings-sectors representatives.

Finally, both partners where present with stands at the international building fair SAIE in Bologna, at EcoMondo in Rimini and ECO-LIFE in Biella, and a final international conference was organized by Province of Biella, hosting 61 participants and published on the [www.novedi.it](http://www.novedi.it) website by proceedings, a video registration and an English audio-registration.

**Action n° 7** concerned the mandatory dissemination activities. Sasil dedicated a specific part of its LIFE website to the NOVEDI project, [www.sasil-life.com/novedi.htm](http://www.sasil-life.com/novedi.htm). Where this website has a rather technical approach, Province of Biella, within the framework of its activities under Action 6, created a portal under the name [www.novedi.it](http://www.novedi.it), where all its activities developed in the framework of the project towards citizens and construction sector are shown and running. Obviously both websites are referring to each other.

By March 2009 a notice board has been erased at the Sasil production plant in Brusnengo. At the Province the notice board has been installed by the beginning of October at the start of its dissemination activities.

**Conclusions**

The NOVEDI project, through an original special glass processing technology, focused on glass rejects not included in cities’ separate waste collection but usually landfilled, has enabled the reuse of these glass rejects into foam glass, a porous gravel of apparent density of 0.2 kg/liter, with remarkable characteristics of thermal insulation usable in the building sector.

A confrontation with the expected results:
1. Demonstration of a series of glass-based cellular insulation material which allow to reduce to zero the land-filling of special glass rejects and quarry of primary resources: the final products recycles in particular soda lime glass rejects; front monitor glass rejects; fiber glass rejects; lamp and artistic glass rejects. They are transformed into 2 certified products: foam glass suitable as inert for lightweight structural concrete (density 1800 kg/m3) for roof and floors and for super-lightweight insulating concretes (density 1000 kg/m3) for the walls.

2. Consumption of special glass reject during project realisation was expected to be about 150 ton, producing about 750 m3 of glass-foam. Of this, 80 ton of recycled glass has been used for the building, for a total of 400 m3 of glass foam, the remaining part for the trials.

3. Demonstration of economic viability of introduction on the market of glass-based cellular materials with high performance in thermal insulation, mechanical strength and lightness, fireproof, moisture insulation and technical reversibility: economic assessments showed that a production plant about 4 times as big as the pilot plant would be able to obtain a competitive sales price in the insulation/building materials sector.

4. A demonstrative building, evidencing all the assets developed: the building is still in construction, but as emblem of the project results, it will feature the following achievements:
   - Use of the developed foam glass as inert in the composition of lightweight structural concrete (density 1800 kg/m3) for the floors and super-lightweight insulating concrete (density 1000 kg/m3) for the walls
   - 80,000 kilo of previously unrecyclable glass has been used, composed of 85% soda lime glass rejects; 5% front monitor glass rejects; 5% fiber glass rejects and 5% of a mixture of lamp and artistic glass rejects.
   - Foreseen energy consumption of 15 kWh/m2/year, which can be fully produced by the photovoltaic installation
   - As extra unforeseen assets: 80% recycled materials have been used, namely:
     - 80,000 kg of glass otherwise destined for landfill;
     - 250 m2 of tiles with base dough containing recycled glass treated by Sasil;
     - 200 m2 of artificial mineral wool produced from various waste materials, amongst which incinerator slag, processed at the Sasil plant (roof insulation);
     - 50 m2 of photovoltaic panels, whose ultra-clear glass was produced from recovered quartz, with high purity silica provided by Sasil to a flat glass factory specializes in the production of glass for solar panels.
   
   In addition, the LCA performed on this building led to the result of complete recyclability of the foam glass materials used.

5. Sensibilisation and stimulation of citizens and of the construction sector in Northern Italy to employ energy efficient and eco-compatible building materials recovered from waste, able to allow for a complete recycling of the land-filled special glass rejects. Quantified:
   - Instead of the foreseen financial support instrument, realisation of an information energy desk with portal www.novedi.it
   - 1 information campaign towards citizens in the Province of Biella on both technologies and financial support schemes (meetings, participation to fairs, diffusion of materials)
   - 3 informative meetings with stakeholders of the construction sector (instead of 2 foreseen) and – unforeseen - network of all stakeholders, still operational
   - informative actions towards other Public Authorities and – unforeseen- building sector at international fairs SAIE and EcoMondo and at Ecolife Expo.
   - final international conference for 61 (100 foreseen) stakeholders of building, waste treatment and energy sectors, as well as public authorities, published subtitled.
3. Introduction

Objectives: Demonstrate the feasibility to abolish landfilling of glass rejects that, due to their particular chemical compositions cannot be recycled, neither by glass container nor by ceramic industry. Examples are television screens, mosaic and artistic glass, PVB containing glass from the car industry, glass textile sheets, glass of lamps. The project would demonstrate new technologies which allow their use in glass based insulation materials with a high performance in thermal insulation, mechanical strength, fireproof and eco-compatibility, which traditional production is too expensive for a large market introduction.

The specific objectives can be summarised as follows:
1. demonstrate the possibility to reduce to zero the land-filling of increasing amounts of special glass rejects, containing lead, fluorine etc., which represent a high threat to the environment;
2. allow the wider introduction on market scale of glass based insulation materials, by producing them from actually unrecyclable glass rejects and thus reducing their price. This material has a performance in resistance, safety and reversibility which is much higher than the commonly used polyurethane, insulation material which requires scarce petroleum resources.
3. make Italian construction sector and citizens familiar with eco-compatible and energy efficient construction materials, in particular glass-based insulation materials, as to assure future sufficient demand for recycling of all glass rejects actually landfilled in North Italy.

Technical solutions: A pilot process will be developed and realised based on four different treatment sections, for respectively (1) grinding of mixtures into defined particle sizes (2) mixing of obtained glass powder and additives, (3) foaming and (4) crushing of the glass foam sheets. With this product, light concrete will be realised and a building will be constructed. A sensibilisation and information campaign towards construction sector, citizens and local public authorities will be undertaken, based upon a feasibility study and networking stakeholders.

Main expected results and environmental benefits
1. Demonstration of recyclability of special glass rejects actually landfilled and representing a high threat to the environment
2. Demonstration of economic viability of market-introduction of glass-based cellular materials with high performance in thermal insulation, mechanical strength and lightness, fireproof, moisture insulation and technical reversibility
3. Consumption of special glass rejects of about 150 ton, producing about 750 m3 of glass-foam
4. A demonstrative building, evidencing all the assets developed, 100 % energy-autonomous.
5. Stimulation of citizens and construction sector in Northern Italy to employ energy efficient and eco-compatible building materials recovered from waste.

Expected longer term results
On an impact level, a preliminary study on market potentialities demonstrated that employing the 80,000 ton/year of special glass rejects which are today available in Northern Italy, would lead to a production of ca. 400,000 m3/year of glass-based cellular insulation materials (specific gravity 0.2kg/litre) which, compared to actual consumption in Switzerland of similar products (with public financial support!), would satisfy the potential needs of the Northern Italian market. Obviously, achievement of these targets highly depend on market development, which can be boosted by sensibilisation actions, by fiscal facilitations and by high energy prices. But most important factor is economic growth in the building sector.
4. Administrative part

4.1 Description of the management system

Description of working method

The project was organised in the following phases:

- **Action 1** Characterization of the materials involved (01/01/09-30/06/2009)
  Laboratory works to define several user options and process parameters.
- **Action 2** Preparation of starting glasses (01/01/2009-31/07/2010)
  A series of chemical/physical treatments, in order to separate organic and inorganic materials from the various glass types, and to obtain treated glass with the characteristics defined in action 1 and suitable to be employed in production of glass foams.
- **Action 3** Preparation of glass based cellular materials on laboratory scale (01/07/2009-31/03/2010)
  Different mixtures of starting glasses have been foamed using different processing variables.
- **Action 4** Creation of pilot installation and experimental production of granules and blocks (01/01/2010-30/11/2011)
  The plant is based on four different treatment sections: 1) grinding mixtures; 2) mixing of glass powder and additives, 3) baking; 4) crushing of glass foam sheets delivered by baking process.
- **Action 5** Construction of Civil Building made with light concrete based on glass foam (01/06/2010-31/03/2012)
  To demonstrate in a clear and convincing way the technology which has been proven feasible.
- **Action 6** Sensibilisation and dissemination of the results towards construction sector, citizens and public sector (01/06/2009-31/05/2012)
  Activities included a feasibility study on how to enhance ecologic and energy-efficient building; an information campaign towards citizens and construction industry, supported by an Energy desk; presentations at fairs and manifestations, and a final international conference.
- **Action 7** Obligatory dissemination actions: notice board, website and layman’s report (01/01/2009-31/05/2012)
  Design and production of notice boards, website management and production of layman’s report.
- **Action 8** Project management by the lead partner SASIL (01/01/2009-30/06/2011)
- **Action 9** Project management by the partner Province of Biella (01/01/2009-30/06/2011)
- **Action 10** Monitoring (01/01/2009-30/06/2011)
- **Action 11** Audit (01/01/2009-30/06/2011)

Presentation of the beneficiaries and their tasks

SASIL S.p.A., a medium enterprise born in 1975, can boost upon a huge experience in mines exploitations and in natural minerals treatment. SASIL has its own R&D department focusing more and more on recovery of waste. From 2005 onwards SASIL developed a process for treating glass rejected from primary cullet plants transforming it into raw materials for glass containers, ceramics, bricks and cement industries (LIFE-project MEIGLASS). The NOVEDI project was the logical follow-up, focusing special glass rejects not recyclable today. Since January 2010 a process is being developed for recycling of glassy combustion residues (slag and fly ashes) of (co-)incinerators into glass wool and glass foams (LIFE-project VALIRE). Since several years Sasil has been studying recycling photovoltaic panels, pilot activities are foreseen to start next year (FREL P project). Within NOVEDI, Sasil is in charge of general project management and development of the technological project activities.

Province of Biella is located in Piedmont region, comprises 82 municipalities and nearly 200,000 inhabitants. In the energy sector, the Province has a service for Air Quality and
Energetic Resources (Servizio Qualità dell’Aria e Risorse Enegetiche), which deals with the institutional activities related to energetic resources and stimulation of energy efficiency. The Province is also actively involved in development of new technologies on the territory. Within NOVEDI, the Province of Biella is responsible for the sensitisation and dissemination actions towards citizens, enterprises and public sector foreseen in the project.

**Project organisation and organisangement**
The project has been supervised by Lodovico Ramon, SASIL’s managing director. Scientific-technical management has been carried out by Piero Ercole, in charge of monitoring project progress and quality. Local coordinator of works carried out within the SASIL plant was Edoardo Poletti. Paolo Bertuzzi was responsible of scientific trials. The financial officer of SASIL, Grazziella Aina, took care of the financial management of the project. The team was assisted by a consultant for legal, administrative and financial issues, Gertrud van Leijen. Project leader within the Province of Biella was Davide Zanino, director of the Sector Technological Innovation and Communication, while Cristina Pagliazzo was day-to-day project coordinator. The coordination committee is composed of the supervisor and local coordinator of SASIL and the project leader and coordinator of the partner Province of Biella.

The project supervisor stipulated the partnership agreement, represented the partnership towards the European Commission, took care of receipt of EC contributions and transfer to the partner, monitored physical and financial progress, coordinated generally the project, chaired the project’s Coordination Committee and was responsible for reporting. Mrs. Grazziella Aina was in charge of financial project management, collecting documentation from the partner and keeping accurate accountings of project expenses and income. The management was supported by Mrs. Gertrud van Leijen, who reviewed on a regular base (a. half-yearly) financial documentation, advised partners on administrative and financial issues, monitored financial and technical progress, advising the project supervisor on the results, prepared the partnership agreement, coordinated preparation of reports to the Commission and prepared the amendment request, under the direct supervision of the project leader. 9 meetings of the Coordination Committee have taken place aimed at defining and coordinating joint activities, monitoring physical and financial progress and evaluation of results.
The inception report was presented on 30/09/2009, the Mid term report on 04/06/2010 and the progress report on 16/03/2012. A request for amendment has been presented on 30/03/2011 and was accepted and signed on 26/06/2011 by the Commission.

**Partnership agreement and key content**

The partnership agreement (Annex 1) was signed on 16/04/2009 and delivered with the inception Report (electronic Annex 1). The format proposed by the commission has been adopted. Role and obligations have been defined according to the Common Provisions. The organisation structure and the functions of the Coordination Committee are defined, as well as report obligations and payment terms. Rules for subcontracting as well as Audit and inspections are copied from the Common Provisions, civil liability of each beneficiary is established, conflicts of interest are regulated, Communication rules are derived from the CP and the approved project description; confidentiality is safeguarded, estimated eligible costs and associated beneficiary's financial contribution to the project are copied from the approved project description. Termination of the agreement, property rights and settlement of disputes are duly arranged.

**4.2 Evaluation of the management system**

Process, project management, problems encountered, partnership and its added value

The project management was very satisfactory, not in the least due to the pleasant and compliant collaboration of Partner Biella, whose contribution to the project by the competent development of a huge set of sensibilisation and dissemination activities was indispensable. The support of the legal-financial and administrative consultant in reviewing financial documentation and advising on contractualisation rules, calculation of daily staff costs, timesheet registration, bookkeeping, reporting obligations and publication rules permitted partners to avoid errors, resulting in fully audited expenditures. Her support to project monitoring, reporting and legal management permitted the project supervisor to keep track of compliance and concentrate on the management of core activities, quality control and evaluation of results.

Within the Province of Biella, the transfer of project coordinator Cristina Pagliazzo to another unit created a short time of difficulties, which were overcome when a substantial part of her work was transferred to Mirella Laudano, remaining Mrs. Pagliazzo however supervising so to conserve the acquired experiences. The hospitalization of the legal-administrative consultant caused serious delays in the presentation of the progress report, but LIFE monitor Mrs. Roccato fortunately demonstrated her comprehension.

Meetings were organised according to the needs, thus occurred more frequent at project start and during periods of many dissemination activities. Usually, the Coordination Committee met with participation of the consultants and the scientific trials manager. Sasil’s local coordinator often didn’t participate as his activities were more concerned with the organization of internal works (construction, plant operation) while the technical results to be discussed in the Committee were assessed generally by the scientific-technical coordinator and the scientific trials responsible, with support of Padua University.

**Comparison against the project-objectives**

Objective of project management was 1) the fulfilment of all duties deriving from the subsidy contract; 2) project’s progress according to the established timetable and task division; 3) achievement of expected results; 4) auditing of expenses.

1) The first objective has been achieved, although the mid-term report was delivered with 2 months delay as to achieve the threshold for interim payment, and the progress report was delayed with 7,5 month, due initially to technical uncertainties on interpretation of outcomes of analyses still in course; and later to both problems mentioned above.

2) Observation of the timetable has been achieved as far as dissemination activities concern, but technical activities unfortunately met too many problems to be solved to respect the timetable.
3) Foreseen results have been achieved.
4) All presented expenses have been approved by the auditor.

The future: continuation of the project and remaining threats
Sasil will continue execution of the project, which it expects to conclude by May 2013. Thereafter, it will increase its focus on market introduction of the developed glass foam, with the hope to be able to construct an industrial plant within a few years. Severe constraint today is however the economic crisis in the building sector which hamper investments and acceptance of new products.

Province of Biella kept alive the stakeholders network of the building sector and the online portal NOVEDI which functions as well as web-energy info desk. The physical desk realised during the project is now being run by two stakeholders, CNA and Confartigianato, which appeared more cost-effective and can assure a long-term sustainability. Their websites are linked to the NOVEDI platform. Severe cuts in Province’s budgets by the Italian State are jeopardising actually any future activity not strictly belonging to Province’s core-business. Moreover, forthcoming merging of Biella with a neighbourhood Province offers additional uncertainties on future policies and activities.

Technical and commercial application of project results are extensively described further in chapter 5.3.2 and 5.3.3. Effectiveness of dissemination activities in 5.3.1 and especially 5.4.1.
5. Technical part

5.1 Task by task action - description

5.1.1 Action 1 Characterisation of the materials involved (01/01/09-30/06/2009)

Activities carried out
The action has been implemented both at the SASIL Brusnengo plant (Province of Biella, Italy) and at the Department of Material Engineering at the Padua University, which supported SASIL scientifically. It has been completed in the foreseen period of time: January - June 2009.
To realize this action, SASIL delivered samples of each special glass type which were treated before in order to remove as much as possible organic and inorganic non-glass substances, which could influence the behaviour of the phases of ionic desorption and heating emissions.
The characterisation of the special unrecyclable glasses consisted in carrying out a series of laboratory tests. The chemical analyses on ionic desorption and emissions produced during heating has been done successfully (see Deliverables 1a and 1b). The achieved data allowed defining the behaviour of the special glasses different types in function of different percentages in different mixtures.

Special glasses characterization results
A test report is attached (electronic Annex 2) that explains the complete theoretical preliminary study done by SASIL with the scope to optimize the foaming behaviour of a series of mixtures. These have been defined, taking into account the quantity availability of each glass type and blending together with the soda lime glass the special glass rejects trying to compensate as much as possible their different chemical-physical characteristics between them.

In Table n°1 the chemical analysis of each unrecyclable special glass type and some rejected materials that could be useful as additive and their calculated physical properties are reported.
In it, the two first columns are dedicated, for an easy comparison, to two typical soda lime glasses chemical analysis and their properties.
The first one is typical for a glass container soda lime glass and the second one represents the average analysis of the “Glassy Sand”, a new raw material produced by SASIL starting from the dirty cullet rejected by the primary cullet beneficitation treatment unit that has been already used, with success, for insulation glass foams production.
It is interesting to observe the following important points:

- The light green indicates values which are in the range of soda lime glasses.
- The brown colour indicates values that are out from the above said range; darker is the colour farer from the soda lime glasses are the considered values.
- The pink colour indicates values which are far from the soda lime range but in the opposite direction.
This, in other words, means that mixing together special glasses that, if taken alone, give problems during foaming, when blended together in the proper ratio and respecting, in possible limits, the quantities available of each one, will produce a glass with chemical-physical characteristics close to the soda lime ones. This logic, clearly explained in the test report, allows for a much better foaming reactions control and a much easy possibility to achieve the expected results.
- The same consideration can be done for the physical properties.
In the test report all the explanation and consideration regarding the types of blending in order to optimize the unrecyclable special glasses reuse with a high added value are reported.

<table>
<thead>
<tr>
<th>Character.</th>
<th>Soda lime Italian average</th>
<th>Glassy Sand</th>
<th>Glassy Arteglass</th>
<th>Lamps CRT Front</th>
<th>CRT Retro Mosaic</th>
<th>Old Fibre w/ B2O3</th>
<th>New Fibre no B2O3</th>
<th>Slag from factory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sigla</td>
<td>RIFER VV VA BL MF MR MS FT FN SC FF</td>
<td>Chemical Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SiO2</td>
<td>72.30 72.92 73.16 76.43 76.73 74.24 55.18 62.68 58.3 72.45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Al2O3</td>
<td>2.200 2.200 1.650 1.500 2.000 2.000 5.500 15.000 17.000 2.200</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Fe2O3</td>
<td>0.250 0.300 0.170 0.120 0.070 0.070 0.140 0.300 0.220 5.000 0.300</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>TiO2</td>
<td>0.020 0.100 0.050 0.060 0.300 0.300 0.020 0.200 0.000 0.100 0.100</td>
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<td></td>
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<tr>
<td>Na2O</td>
<td>13.500 12.000 13.000 13.000 6.500 8.500 11.730 0.000 0.000 12.000</td>
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<td></td>
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<tr>
<td>K2O</td>
<td>0.700 0.900 2.000 1.200 5.300 5.300 2.800 0.400 0.500 0.300 0.900</td>
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<td></td>
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<tr>
<td>CoO</td>
<td>11.000 10.000 5.200 6.500 2.000 2.000 5.360 7.000 7.000 10.000</td>
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<td></td>
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<tr>
<td>MgO</td>
<td>1.500 2.000 0.160 3.500 0.700 0.700 0.030 1.000 1.000 3.200 2.000</td>
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<tr>
<td>B2O3</td>
<td>0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000</td>
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<td></td>
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<tr>
<td>P2O5</td>
<td>0.100 0.050 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cr2O3</td>
<td>0.190 0.190 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000</td>
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<tr>
<td>Total</td>
<td>100,000 100,000 100,000 100,000 100,000 100,000 100,000 100,000 100,000 100,000</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Availability ton/month</td>
<td>- 12000 300 100 300 200 200 800 800 400 100,000</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

### Physical Properties

| TiO2       | 1431 1486 1513 1515 1724 1662 1511 n.d n.d n.d 1489 | |
| TiO3       | 1183 1222 1253 1229 1375 1324 1300 n.d n.d n.d 1220 | |
| TiO4       | 1024 1054 1059 1050 1152 1110 1098 n.d n.d n.d 1051 | |
| TiO5       | 908 933 927 927 1009 971 962 n.d n.d n.d 934 | |
| TiO6       | 826 846 832 836 988 948 914 n.d n.d n.d 847 | |
| TiO7       | 755 782 756 767 793 768 786 n.d n.d n.d 781 | |
| TiO13.4    | 591 557 514 537 492 486 532 n.d n.d n.d 556 | |
| Density    | 2.5164 2.5020 2.4578 2.4771 2.3960 2.5348 2.4452 2.4992 | |
| T Liquidus | 1049 1057 885 958 893 867 947 n.d n.d n.d 1057 | |
| Cool Time  | 98.125 96.999 114.98 105.89 120.222 122.822 109.59 n.d n.d n.d 97.556 | |
| Expos      | 89.918 83.922 83.340 83.790 66.288 71.414 81.158 n.d n.d n.d 83.301 | |

### Characterization of the elements emitted by each special glass when heated up for foamed glasses formation

As has been foreseen in the scheduled activities of Action n° 1, a series of test has been done with the scope to determine types and concentrations of chemical elements emitted heating up each type of special glasses at the foam formations temperatures. The tests have been done at 900 °C and 1100 °C and then compared with the limits fixed by the European Authority.

All the systematic analysis are discussed in the Deliverable 1b in which the achieved conclusions are very comfortable because the emissions tests have not revealed any problem. Only the emission of selenium from the artistic glass at 1100°C exceed the Legislation limit but it must be recalled that the optimized temperature for producing glassy foams of high quality level is 900°C in which the determinate emission are below the limit.
In any case, as clearly explained in Annex n° 2, the artistic glass contents of the mixtures to be foamed will be at most around 10% and very far from the conditions that can exceed the selenium emission limit.

Tests on ionic desorption in water of selected waste glasses
Part of the starting glasses need to be washed in order to remove the water soluble organics compound that, due to their strong reducing effect, can give problems during the foams formation (see Action 2). The waters coming out, after each special glass wash, from the system were chemically analyzed with the aim to determine the heavy metals leached out from the glass by the water itself. This control has been judged essential in order to be sure of avoiding the heavy metals accumulation in the washing water that, as is known, will be fully recycled and used for all the special glasses to be treated.

The study, assigned to the Padua University, as expected, gave very good results that are deeply explained and oriented in Deliverable n° 1a. The achieved results are satisfactory because the heavy metals, present in some of the special glasses, are linked together with the glass oxides in the glass structure and can not be released, at all, with neutral water (pH around 7) at room temperature.

Total costs of the action were 74,637 € (96% as what was expected).

Problems encountered and solutions found
As far as photovoltaic panels concern, they had to be excluded yet from the very beginning: it appeared that no availability exists to date to receive only the glassy compounds of the panels, as detachment of the EVA module appears still to be too difficult to perform. SASIL assessed in parallel to the NOVEDI project potential technologies to perform this detachment and further processing, resulting in 2012 in a project proposal for the realisation of a dedicated pilot treatment process.

It must be recalled that the traditional process for producing glass foams has been studied and defined for typical soda lime glasses tailored to obtain the required chemical and physical properties and in particular the viscosity behaviour against the temperature and the devitrification tendency of the glasses during foaming.

On the contrary, the project intends to produce glass foams using the parts of glass cullet which are not actually included in the recycling processes, as lamps, neon tubes, decorative mosaics, insulation fibres, television screens, computer monitors and photovoltaic panels. These particular special glasses do not respect the range of the above said properties: Some of them for the viscosity/temperature curve and some for the devetrification temperature itself that is too close to the foaming temperature range.

The difficulties due to these differences have been clearly described in the last study done by the Department of Material Engineering of the University of Padua previously to the start of the project and had to be resolved by the laboratory tests at stake in this action.

The brining of organic and inorganic substances may influence the behaviour of the glass in the phases of ionic desorption and heating emissions. In order to minimize this risk, Sasil provided the laboratories with pre-selected and pre-treated samples.

The emission tests (see Deliverable 1b) confirmed that the glassy materials themselves will not originate any emission. In fact, they will be heated up at temperatures range of 900-950 °C, while, as is known they has been melted before (at the beginning of their life-cycle) at a temperatures range of 1,400-1,500 °C.

This makes it impossible that further emissions are to be expected, other than a marginal amount of CO2 which is not retained in the porosity of the glass. (Instead, the glass foam retained itself a high amount of this CO2).
Also the tests on ionic absorption revealed that waste water from the washing process can be entirely re-used in the production plant as no harmful residues are released.

**Achievement of objectives**
The action was completed as expected in June 2009. The emissions tests were successful. Only the emission of selenium from the artistic glass at 1100°C exceed the Legislation limit but it must be recalled that the optimized temperature for producing glassy foams of high quality level is 900°C in which the determinate emission are below the limit. In any case, as clearly explained in the test report, the artistic glass contents of the mixtures to be foamed was expected to be around 10% and very far from the conditions that can exceed the selenium emission limit.
The tests on ionic desorption in water of selected waste glasses was satisfactory. It is guaranteed that the heavy metals, eventually present in the special glasses to be washed, are fully resistant to the water attack and no accumulation of them will occur in the washing water. It will be totally recycled through a physical-chemical process by which water soluble organic materials will be extracted.

**Completed deliverables and other outputs**
All delivered with the inception report:
- Test report ‘Preliminary studies for the production of glassy foams characterized by low specific weight, high mechanical strength and very strong heat insulation power exploiting the unrecyclable special glasses today destined to the landfill”, delivered 30/06/2009 (electronic Annex 2).
- Deliverable Action 1a: Report on the ionic desorption in water of selected waste glasses (Padua University, Department of Mechanical Engineering, Sector Materials). Delivered 30/06/2009. (electronic Annex 3)
- Deliverable Action1b: Report on the gaseous emissions at 900 and 1100°C from special glasses to be used for producing glass foams with low specific weight and high mechanical strength and heat insulation capability (Padua University, Department of Mechanical Engineering, Sector Materials). Delivered 30/06/2009 (electronic Annex 4)
5.1.2 Action 2 Preparation of starting glasses (01/01/2009-31/12/2009)

Activities carried out
The preparation of starting glass powders for the production of glass foams has been studied and experimentally proven with good results, respecting the scheduled timetable. The starting glasses were used in the tests carried out in Action 1 and later in those of Action 3.

This phase has been realized following and adapting a series of physical treatments based on the technologies actually employed within SASIL for natural mineral and soda lime glass treatments. The inorganic non glassy materials have been removed with floating techniques, metal detector for non magnetic metals and magnetic system for iron.

Then some of the special glasses have been washed with water to remove the water soluble organics compound that, due to their strong reducing effect, can give problems during the foams formation. This washing phase has been realized only for some of the special glasses that, for their nature, can contain soluble organic materials.

Each special glass, after the above described treatments, has been dried and then grounded with a high pressure roller mill obtaining a glass powder with size 100% lower than 300 microns. Of course, each unrecyclable special glass has been treated separately from the others.

The last six months of Action 2, have been spent to optimize the maximum size of the special glasses powders, lower than 300 microns, in function of the foaming kinetic and micro pores dimensions and homogeneity that have been measured and evaluated in the laboratory continuous foaming trials (Action 3).

The results of the tests were carefully studied as far as quality and costs of the final product concerned, in order to assess the economic viability of market introduction of the new material. The economic study was concluded only after the last tests with the starting glasses within Action 3, in order to take into account all necessary test-results.

The Action run according to the expectations and has been completed as foreseen within December 2009. However, the production of 150 Ton of treated glass for the construction of the demonstration building has been done during the first semester of 2010.

Total costs of the action were 526,230 €, 99% of what was foreseen.

Problems encountered and solutions found
No unexpected problems arose and solutions to the expected ones were found. This regarded especially the extreme flexibility and elasticity of fiber glass, which make grinding into micrometer size complex. The new wet process technology allowed for the necessary reduction of the starting vitreous material to be used for foaming into the necessary average particle size between 20 and 25 micron.

Achievement of objectives
1. Sufficient starting glasses were prepared within the set timeframe to allow for the tests in Action 1 and experimentations in Action 3. All tests done with the prepared starting glasses until the end of March 2010 gave the foreseen results, and brought to the realisation of special treated glass, which is suitable in its chemical and physical characteristics to be used as basis for the following production of the glass foam.

The residual inorganic and organic contents in the final powders, compared with the ones of recycled soda lime glass – which until today is used to produce glassy foams, were on line or even better (all the COD contents measured on the powders obtained from each special glass available for the NOVEDI project were lower than 100 mg/liter).
2. The economic compatibility appeared to be excellent, and the results were laid down in the Report “Justification of the economic compatibility” expected by 31/12/2009, but written after the completion of all the experiments foreseen in Action 3. The achieved results show that the overall costs of the production, taking into account both the negative prices of each special glass (saving of land-fill cost) and none technological compliances, thanks to the stability of all the special glasses against the hydrolytic attacks and to the absence of pollutant materials during foaming, are lower than the conventional foaming of classic soda lime glasses alone.

3. 150 Ton of treated glass has been produced in order to provide sufficient materials for the operation of the pilot plant and for construction of the demonstration building.

Completed deliverables
• Deliverable Action 2. Report “Justification of the economic compatibility.” Expected by 31/12/2009, delivered after closure of Action 3 by the 31/03/2010. The deliverable has several attachments showing the design of the pilot plant. Delivered with the mid-term report and hereby attached in electronic copy Annex 5.

5.1.3 Action 3 Preparation of glass based cellular materials on laboratory scale (01/06/2009-31/03/2010)

Activities carried out
For optimization of the foams a correct mixture between special glasses and soda lime glass is needed in order to assure the physical and chemical properties of the end-products. These mixtures have been fine-tuned during the last year. Moreover, the production process needs to be fine-tuned for correct heating and cooling timing: These parameters are very important for providing optimal strength of the end-products. This process can only be sufficiently assessed by trials in continuous, which has been carried out on laboratory scale during this Action. The achieved results are of great importance for scaling up the process to be assessed prior to start with production in the pilot plant within Action 4.

SASIL S.p.A. started this action earlier than originally foreseen, because it decided to do a series of laboratory tests in order to screen the mixtures of special glass powders and selecting the more promising conditions. These have been studied deeper in continuous, exploiting the new continuous laboratory furnace acquired by SASIL. All the experimental trials have been done under the supervision of the Padua University that provided, already, the laboratory equipments for the characterization of the glassy foams. First ‘flash’ trials concerned the discontinuous preparation of glass foams in a discontinuous furnace of the University of Padua starting from mixtures of different glass powders produced following the conditions established in Action 1.

After acquisition of the laboratory continuous furnace at Sasil, 24 series of experimental tests have been carried out, in discontinuous first and in continuous laboratory furnace later on. The trials have been carried out with this furnace, which allowed a better timing control for heating, although during the first months of use alimentation took place by intervals. The tests were divided in the following way:
• n° 7 series of 5 tests each mixing together the soda lime glass (Glassy Sand) with the mixtures of the two Monitor (MF and MR 60/40)
• n° 7 series of 5 tests each mixing together the soda lime glass (Glassy Sand) with the mixtures of artistic glass (50%) Glass for lamps (16.6%) and mosaic glass (33.4%)
• n° 10 series of 5 tests each mixing together the soda lime glass (Glassy Sand) with the mixtures of the five special glasses (MF, MR, VA, BL; e MS) in the ratios of their availabilities.

The planning of the tests series foresaw such a large number of experiments because all the three mixtures of special glasses had to be blended, in crescent ratios, with soda lime glass (Glassy Sand) and each blended compound had to be foamed in a series of 5 tests changing the main operational conditions.

The scope of the detailed tests for each series was to play with the foaming reaction parameters in order to make clear, exploring a more open field of conditions, the limit of ratios between soda lime glass (Glassy Sand) and the three types of mixtures on which the glass foam results are not acceptable.

The 120 trials in total allowed, on one side, to define the range of ratios between soda lime glass (Glassy Sand) and each one of the three mixtures on which the glass foams achieved acceptable characteristics and, on the other, to collect data useful to avoid mistakes on the pilot plant.

The results evaluations have been done just looking the micro-pores dimensions and their homogeneity dispersions in the foam mass.

In particular, the following aspects have been the object of the experiments:

• Study the behaviour of the various mixtures of the available special glasses during foaming process, with the aim to identify, for each of them, the optimal ranges of time and temperature within which should be operated in order to avoid the risk of glass crystallization and the increased viscosity at the selected foaming temperature.

• Systematic evaluation of the characteristics of the obtained glass foams (density, macro and micro analysis by microscope, mechanical resistance, etc.).

• Examine the influence of the oxidation coadjutor (manganese dioxide) on the characteristics of the glass foams.

• Examination of the reproducibility of the results by repeating the most significant tests.

The last part of the period has been dedicated to the continuous feeding of the laboratory furnace and on the further improvement of final products. The results evaluation, also for the glass foamed in continuous condition, has been done by assessing the micro-pores dimensions and their homogeneity dispersions in the foam mass.
The last two months of Action 3 time schedule have been dedicated to assess the possibility to use rejects from waste soda lime glass treatment processes instead of normal soda lime glass waste. Within Sasil a Glassy Sand quality problem (MEIGLASS Project) had occurred, caused by the presence of some parts per million of non fusible materials heavier than glass. The problem has been successfully overcome but provoked a small amount of soda lime glass rejects, which cannot be used for Glassy Sand (for glass container industry). This material now substitutes the soda lime glass waste used in the NOVEDI mixtures, achieving a 100 % actually unrecyclable glass composition of the blends.

The action was completed on schedule at the end of March 2010.

Total costs of the action were 170.746 €, 97 % of what had been foreseen.

**Problems encountered and solutions found**

Regarding the compression strength evaluation, some tests have been done but the results must be confirmed during action 4 because the laboratory continuous furnace has a too short cooling zone; the pilot furnace has a cooling zone in which the slow cooling will reduce the brakeage planes and in so doing increasing the strength resistance values.

In any case even working on the laboratory continuous furnace the strength resistance values has been compared with those obtained using the samples done with 100% of soda lime glass achieving very similar results.

**Achievement of objectives**

The results demonstrated that the logical approach (studied and reported in the test report of Annex 2) simplifies the tuning of the mixtures of special glasses to be foamed together; and was functional as well for the definition of the dilution levels with soda lime glassy sand and of the additives.

The results obtained in the continuous trials confirmed the discontinuous ones and are more feasible for programming the pilot plant systematic trials that will be in progress very soon.

Concretely, the evaluation of the overall continuous laboratory tests clarified that the best conditions to start the pilot plant long trials are the following:

- Glass powder composition 80% soda lime glass (Glassy Sand) and 20% mixture of the five special glasses (MF, MR, VA, BL and MS).
- A second option for the glass powder composition can be 70/30.
- Reducing agent Silicon Carbide 2% on weight on the mixture
- Oxidation coadjutor CaSO4 0.5% on weight on the mixture
- Reaction temperatures 900°C
- Time 20 minutes

These conditions are good enough for going further with the pilot plant trials. It is very possible, however, that some changes will be necessary to exploit the pilot unit design and foaming capacity that will allow:

- better feeding mixtures homogeneity,
- optimized continuous charging of the conveying furnace and
- more accurate temperature control as well as heating and reaction times control.

The conclusions are of great aid for defining the pilot unit trials program which should evidence the best conditions to be adopted for the production of glass foams needed to prepare the light, strong and high heat insulating concrete from which to build the energy efficient demonstration building.
Completed deliverables and other outputs

- Report “Discontinuous preliminary unrecyclable special glasses foaming tests done for screening the conditions to be applied in the laboratory continuous trials”.
  Delivered with the inception report and hereby attached as electronic Annex 6
  Delivered with the mid-term report, and hereby attached as electronic copy annex 7.

5.1.4 Action 4: Creation of pilot installation and experimental production of granules and blocks (01/01/2010-31/12/2010)

Activities carried out

According to the project description, a pilot installation for the creation of the foam in blocks and granules has been realised: It consists of four sections, of which the first was partially already available within SASIL’s treatment plant:
1. The section for grinding of the mixtures, in order to turn them into very fine glass powder
2. The section for mixing of glass powder and additives;
3. The foaming section in which the glass foams, in panels measuring 4 ÷ 6 centimetres thick and about 1 metre large, will be produced.
4. The foam crushing section, in which the foam is reduced in pieces sized in a suitable dimensions to be used as inert for lightened concrete or as an insulating in granules or blocks.

The tests of Action 1, as well as the first part of experimentations done on Action 3, allowed SASIL staff to define the technical specification of each device of the equipment, which could thus be acquired in advance to the time schedule. The furnace for the pilot plant has been ordered in October 2009 and has been delivered to SASIL at the end of December 2009. All the other components of the pilot plant were ordered in October 2009, and were delivered at the Brusnengo plant in January 2010. They were mechanically assembled on the basements and basic structures that had been erected before.

The commissioning tests were carried out and the pilot plant operations started in July 2010. The plant was running experimentally until January 2011 with diversified additions of the various special glass rejects, in order to understand the behaviour and confirm the data obtained in the lab environment. Results were positive, although the produced materials performed some unforeseen limits, which brought 1) to decide to exclude rear monitor glass rejects from the mixtures; 2) to change the breaking session of the plant and 3) to the necessity to change some features of the demonstration building (see Action 5). For the reasons described below, it resulted necessary to foresee different functionalities of the crushing (or breaking) section in function of different granularity requirements of the glass foam used respectively in structural concrete and highly insulating concrete (for non-bearing walls). The created plant was able to produce the desired material for insulating concrete in granules or blocks, but for its employment in lightened structural concrete, the breaking plant had to be redesigned and modified by substituting part of its equipment.

While modifying the breaking plant, sufficient granules and blocks has been produced to start the building of the foundation of the demonstration building and to prepare for the construction of the walls. The production of the material for the floors and roof was performed during the last months of 2011, using the modified breaking plant.

Meanwhile, part of the plant was used to produce unbroken glass foam to be used as insulating and draining substratum for promotional purposes, to introduce the product on the Italian
market. As the production by the pilot plant of this insulating material with special glass rejects – due to the plant’s reduced dimension – is far from economically viable, the introduction has been done with soda lime glass rejects – allowing not to prepare special glass rejects for their processing. The material could thus be sold for a competitive price which is equal to the direct production costs, as yet reported in the request for amendment of the 29th of March 2011.

The picture of the pilot plant during the installation is shown below:

![Picture 3 – Pilot plant installation](image)

Total costs of the action were 1.635.277 €, 107 % of what had been foreseen.

Problems encountered and solutions found

1) Experimentations were started – according to the project – with special glass rejects of the following consumer goods: front and rear monitor (from TVs), exhausted lamps, mosaic glass, artistic glass and glass fiber.

Foams with acceptable characteristics made with rear monitor glass rejects showed emission of lead during the foaming process exceeding the limits allowed by current legislation. Although resulting within the allowed limits during laboratory tests, industrial treatment did not confirm these parameters. Moreover, the specific weight of the created foam was too high and this would lead to an unduly increase of the weight of the concrete, jeopardizing the environmental objectives of the project. Thus this kind of glass rejects had to be excluded from the mixtures. Front monitor, instead, has a much lower amount of lead which lead to acceptable emission quantities according to the legislation, so this material could remain in the mixture of powdered glass to be foamed up. However, experiments showed a maximum possible concentration of 5% by weight as the reducing environment generates the formation of lead metal that blackens the foam, which – if too visible - would be a market deterrent.

2) Employment of mosaic glass rejects was successful, but a market problem led to exclude the material from the final mixture: it is no longer available in Italy because the company that produced mosaic glass and supplied its waste transferred the manufacturing facility in India. Reason for this is rather bitter: the fluoride content of mosaic glass and the resulting
emissions within the fumes of the smelter exceed today the most recent limit permitted by
the European legislation, de facto closing the European industry.

3) The employment of glass foam in lightened concrete required the construction of a crushing
plant, producing a material with specifically defined particle size. The experimentally
produced glass foam, mixed with concrete, however did not respond to the requisites of
breaking resistance as re-established by the legislator in 2008/2009 for structural concrete,
and showed insufficient performance in terms of elasticity. Thus, Sasil had to involve an
expert on these issues, to assess which kind of improvements would be necessary in order to
achieve a lightened concrete with the correct mechanical properties to be used for structural
needs. It got in contact with Prof. Collepardi (Politecnico di Milan, fac. Civil Engineering
and AD of ENCO Srl), which accepted the challenge to resolve these problems. The
analyses were finalized in April 2011 (attachment 1), and brought to the conclusion that the
particle size and structural characteristics of the glass foam in the mixture should be
changed, which required a revision of the pilot breaking plant, with substitution of
machineries developed previously. This modification was undertaken in summer 2011.
However, use of the material in bearing walls seemed not feasible, so it was decided to add
bearing pillars to the building of normal concrete and keep the high insulating capacity of
the lightened concrete for the walls. Thus, the modification of the breaking plant only
delayed the production of the special foam necessary for the lightened structural concrete for
the floors and the roof, which was thus performed after the production of the lightened
isolating concrete for the walls (end of 2011).

Achievement of objectives

The Pilot installation was ready by 30/07/2010 as foreseen, but revised as far as the breaking
plant concerned, finalized after summer 2011.
The Products’ competitiveness has been assessed by 30/12/2010, but in view of the new
composition, without rear monitor glass and more less expensive soda lime glass, has been
reviewed by September 2011, resulting in an updated deliverable (annex 7).
The experimentations showed that the optimal mixture for the preparation of glass foam to be
employed in both kinds of special concrete characterised by a good mechanical resistance,
excellent thermal and acoustic insulation performance and a particularly low specific weight is as
follows
- Soda lime glass rejects: 85%
- Front monitor glass rejects from televisions: 5%
- Fibre glass waste: 5%
- Mixture of 50 % glass rejects from exhausted lamps and 50 %
artistic glass rejects: 5%

It should be stressed that, instead of using 85% of normal soda lime glass indicated as VSC in
the table 2.5.1 of Deliverable Action 2, in this new composition (see table 5.1 in Deliverable
action 4 hereby attached) we have introduced a new soda lime cullet as reject from current
treatment to produce glassy sand for container industry (see action 3). So, at this point the
mixture is 100% of special glass cullet until today landfilled. In view of the availability on the
market of these types of glass rejects, the above described consumption rates would permit a
complete recycling of foresaid rejects once the product would be sufficiently introduced on the
market, which is to be considered as an excellent result.

Production costs with the pilot plant are obviously too high to deliver a compatible product to the
market, especially due to the amount of labour force necessary for its operation. According to the
competitiveness assessment, operation with a plant 4 times as big as the pilot plant would lead to
a production price of 43,60 €/m$^3$, against a current market price of normal glass foam of about 50 €/m$^3$.

**Completed deliverables and other outputs**
- Deliverable Report: Verification of the competitiveness of the product, delivered on date 30/09/2011. Delivered as annex 2 with the progress report and hereby attached in electronic copy as annex 8.

![Picture 4 – Foam Glass at the exit of the furnace](image-url)
5.1.5 Action 5: Construction of Civil Building made with light concrete based on glass foam (01/06/2010-31/03/2011)

Activities carried out, problems encountered and solutions found

The design of the demonstration building had been prepared yet at project start, but underwent modifications until spring 2011, due to comparison of the structural characteristics of the concrete to be produced employing the new glass foams with the modified building legislation in recent years regarding higher requisites to anti-seismic provisions. This led to the necessity to substitute bearing walls with bearing pillars and to a further study of the preparation of structural concrete lightened with glass foam for specific use in the floors and in the particular roof construction. Relative studies were carried out by the civil engineering company ENCO srl. of prof. Collepardi (hereby attached, Annex 9), which defined how to address these new requirements – leading to the newly designed breaking plant (see above action 4). Although the compliance of the special concrete to be employed had been ascertained by foresaid engineering company, according to the architect who directed the works, it had to be certified by an EC recognized agency prior to its employment. The request for this certification was prepared by consulting firm Qu.Am.Si. and presented to Certichim. It arrived unfortunately on 29/03/2012, delaying the construction of floors and roof. Two certified products were obtained: Misapor 0-10mm and Misapor 10-31mm, to be used respectively for lightweight structural concrete (density 1800 kg/m$^3$) and super-lightweight insulating concrete (density 1000 kg/m$^3$).

In 2010 the terrain where to build the construction had been prepared, and in spring 2011 the foundations had been constructed. The walls have been raised by end of February 2012. Unfortunately, by end of May only the slab of the first floor was ready, as well as the glazing works until second floor, despite it was expected in March to be able to achieve first part of roof construction by end of May.

By end of September 2012, all glass foam based construction works have been completed: the entire casing is in light particularly insulating non structural concrete (permeability: $\gamma = 1.000 \, \text{kg/m}^3; \lambda = 0.24 \, \text{kcal/m}^2/\text{°C})$ and the three floors (ground, first and second) as well as the horizontal part of the roof have been constructed in light structural concrete (permeability: $\gamma = 1.600 \, \text{kg/m}^3$). The roof will be installed within November 2012 and the photovoltaic arch within December 2012. Windows will be mounted within the end of the year, and within spring 2013 thermal system and internal furnishing will be completed. Thus, the inauguration is today expected for end of spring 2013.

Total costs of the action amounted by end of May to 255.513 €, 69 % of foreseen costs. However, it is foreseen that total costs will be at least what has been budgeted.

Problems encountered and solutions found

Originally, the intention was to build the construction with bearing walls of 60 cm thickness, exclusively in light concrete. This intention had to be abandoned because of some legislative changes, announced in D.M. 14 January 2008 (Technical Construction Rules, ‘Norme tecniche per le Costruzioni’) and detailed in Circolare 2 February 2009 (Instructions on the application of the Technical Construction Rules’, ‘Istruzioni per l’applicazione delle Norme Tecniche per le Costruzioni di cui al D.M. 14 Gennaio 2008’). In fact, the Italian legislator considers in these regulations the entire Italian territory as seismic, and assigns to each specific municipality requirements of a certain level. This required major reinforcement of the concrete and higher requisites to breaking resistance of concrete used for structural purposes (requisites which are however much higher than in most other places in Europe), jeopardizing the insulating performance.

As far as the walls concern, the solution has been found in increasing slightly the specific weight of the special concrete, and in adding bearing pillars to the construction, with traditional concrete
of class C30/35, while the light concrete produced with foam glass as developed in the NOVEDI project will be used in the 60 cm thick walls, which thus do not have anymore a static function but exclusively an isolating function.

As far as the roof and floors concerned a reformulation should be found in order to respond to the requisites of breaking resistance as re-established by the legislator in 2008/2009 for structural concrete, and to the insufficient performance in terms of elasticity (see also action 4). Thus, Sasil had to involve an expert on these issues, Prof. Collepardi, to assess which kind of improvements would be necessary in order to achieve a lightened concrete with the correct mechanical properties to be used for structural needs in floors and roofs. Studies carried out at the beginning of 2011 evinced that the solution would lie in a modification of the breaking plant, influencing particle size and structural characteristics of the produced glass foam. The breaking plant was adapted in this sense, and then started by end of 2011 to produce the blocks and granules for floors and roof.

Although the parameters of the new materials to be used have been proven compliant to the building rules by Prof. Collepardi, registered engineer in Italy, the supervisor of the construction works requires a specific recognition as authorized building material from an institute certified at European level. Preparation of the request was assigned to Qu.Am.Si and certification was done by Certichim (which did as well recent ISO 9000 certification for Sasil). The construction of the walls wasn’t jeopardized by this requirement; only the roof construction and floors could be started only when the recognition was received, which despite earlier promises happened only by end of March 2012. Difficulties with the workability of the lightened concrete than occurred, solved by substituting some additives into species which are not common on the market and had to be ordered from abroad.

Based on experiences with the floor construction, the engineer supervising the construction denied its approval to use the structural lightened concrete to the sloping part of the roof: the sloping surface made concrete jetting very difficult bearing serious risks for demixing of the lightened concrete. This could jeopardize the stability, what would have been ascertained only afterwards, and be irremediable. It was thereupon decided to construct that part of the roof in wood and apply glass wool produced with bottom ash from incinerators, developed in the VALIRE project.

SASIL is faithful to be able to complete the building in spring 2013.

Achievement of objectives

All foreseen objectives are expected to be achieved:

- A building with a surface of about 300 M², in three different levels, with n°6 office rooms and a meeting room.

- 400 m³ of foam glass used, equal to a consumption of 80 ton of micronized glass rejects until today landfilled. This amount is lower than originally foreseen, due to necessary changes in the building’s design and the fact that the most original part of the roof has to be made of wood.

- Demonstration of all performance assets of the glass foam products created from special glass rejects: 1) for the floors use of a light structural concrete with medium density, and inserting as inert a glass foam with a cell-like structure with micro porosity, 2) for the walls use of a very light concrete, with low density and by inserting as inert a glass foam with a cell-like structure with medium porosity. 3) instead of the previous solution with a roof covered by normal photovoltaic panel, we decided to apply a very important innovation: to install a big arc in steel with a mobile high efficiency photovoltaic panel that is moving in two ways, rotation and translation, during the day. This implies two big advantages:
1. the exposition of the panel is always the best to capture the sun for maximum energy production;
2. the shadow projected over the south glass big wall protect from the sun during the summer and allow that the sun gets in the building during the winter to warm inside.

- The particular photovoltaic design allows the reduction of the panels to only 50 m2 instead of the planned 160 m2.
- NOVEDI glass foam is also used as insulating and draining substratum

Another not foreseen but important additional result is to be mentioned: 80% of the materials used for the building are recycled, taking advantage of other innovations SASIL performed during last years:
- 80,000 kg of glass otherwise destined for landfill;
- 250 m2 of tiles with base dough containing recycled glass treated by Sasil;
- 200 m2 of artificial mineral wool made with dough produced with various waste materials processed at the Sasil plant (roof insulation);
- 50 m2 of photovoltaic panels, whose ultra-clear glass was produced from recovered quartz, with high purity silica provided by Sasil to a flat glass factory specializes in the production of glass for solar panels.

**Completed deliverables**
- Report ‘Messa a punto di calcestruzzi con aggregati in vetro espanso’ Ing. Silvia Collepardi, Enco Srl.
The report has been delivered with the progress report as attachment 1, and is hereby attached electronically as Annex 9.

The expected deliverable “Report: Characteristics and performance of the building produced with glass foams derived from special glass rejects”, foreseen for 15/03/2012, can only be prepared once the building is in place and functioning, especially as far as the performance issues regard. It will thus be delivered by July 2013.
### 5.1.6 Gantt chart illustrating progress

<table>
<thead>
<tr>
<th>Action</th>
<th>Number/name of action</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
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End date: 31/05/2012
5.2 Evaluation

5.2.1 Methodology applied

The proposed methodology as laid down in the project presentation appeared to be successful in most of its parts, although in the final phases of the project serious problems had to be addressed.

As foreseen, a pilot process has been developed and realised based on four different treatment sections, for respectively (1) grinding of mixtures into defined particle sizes (2) mixing of obtained glass powder and additives, (3) foaming and (4) crushing of the glass foam sheets. With this product, light concrete was realised and a building constructed. A sensitisation and information campaign towards construction sector, citizens and local public authorities was undertaken, based upon a feasibility study and networking stakeholders.

More in details, some improvements to the foreseen methodology were applied based on assessments on the needs made in course of the project:

As far as the characterisations concern (action 1), some more analyses were performed than originally expected, appearing necessary from first assessments. The results, laid down in a test report (annex 2) simplified the tuning of the mixtures of special glasses to be foamed together; and was functional as well for the definition of the dilution levels with soda lime glassy sand and of the additives.

The treatment of starting glasses (action 2) required the development of an innovative wet process for grinding, which resulted successful to achieve the required particle size of the glass powder.

The foreseen continuous lab trials on foaming (action 3) were anticipated with discontinuous preliminary unrecyclable special glasses foaming tests, with support of Padua University, in order to screen the conditions to be applied in the laboratory continuous trials. This contributed significantly to the success of the continuous lab trials and to their timely completion with obtaining good results.

The pilot plant (action 4) was indeed constructed according to the previously hypothesised sections. It appeared though that one of the results obtained in laboratory could not be achieved on pilot industrial scale: foams with acceptable characteristics made with rear monitor glass rejects showed emission of lead during the foaming process exceeding the limits allowed by current legislation. Moreover, the specific weight of the created foam was too high and this would lead to an unduly increase of the weight of the concrete, jeopardizing the environmental objectives of the project. Thus this specific glass waste had to be excluded from the mixture and alternative treatment solutions will be further analysed by Sasil in forthcoming years.

The crushing (breaking) unit of the plant seemed initially to be satisfactory, but once engaging in the creation of light structural concrete, it appeared that new Italian legislation on seismic requirements, implemented during the first years of the project, jeopardized this. Extensive additional research was necessary, carried out with support of prof. Collepardi, to understand which adaptations to the foams used for this purpose where necessary and how these could be achieved. Thus it appeared that modifications were required to the breaking plant. The solutions found resulted effective, leading to certification of the materials produced and start-up of the construction works (though with huge delays).

The methodology envisaged for the demonstration building (action 5) had to be adapted during the project in view of the achieved characteristics of lightened concrete and the new seismic
regulations in Italy (which are the most stringent in the entire Europe and nowadays applied to the whole territory, even where seismic risks are low).

The glass foam produced with the new breaking plant permitted to create a structural lightened concrete with sufficient characteristics in terms of breaking resistance and elasticity, but reducing insulating capacities.

Therefore, for the walls it was decided to increase slightly the specific weight of the very lightened concrete, and add bearing pillars to the construction, with traditional concrete of class C30/35. The extremely light concrete produced with foam glass as developed in the NOVEDI project could so be used in the 60 cm thick walls, which thus do not have anymore a static function but exclusively an isolating function.

While the structural lightened concrete worked out well for the floors, the inclination of the roof prohibited its use, and thus it was decided to make the sloping part of the roof in wood, applying insulating glass wool produced with bottom ash from waste incinerators, result of the VALIRE project.

A substantial improvement was decided for the construction of the photovoltaic panels: firstly the panels could be made of recycled quartz refuses, fruit of recent treatment processes developed within SASIL. Secondly, instead of covering the roof with photovoltaic panels, a highly innovative alternative was decided to be implemented: a big arc in steel with a mobile high efficiency photovoltaic panel that is moving in two ways, rotation and translation, during the day.

This implies two big advantages: (1) the exposition of the panel is always the best to capture the sun for a maximum energy production; (2) shadow projected over the south big glass wall protects from the sun during the summer and allows that the sun gets in the building during the winter to warm inside.

### 5.2.2 Results against objectives

<table>
<thead>
<tr>
<th>Task</th>
<th>Foreseen in the revised proposal</th>
<th>Achieved</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Action 1</strong>&lt;br&gt;Characterisation of the materials involved</td>
<td>1. Definition of several user options in function of the final grain sizes 2. Evaluation of the economic sustainability of each option 3. Acceptable level of ionic desorption across time 4. Acceptable level of emissions produced during heating</td>
<td>1. Two products: with glass foam lightened structural concrete; with glass foam lightened concrete with extremely high insulation capacity 2. Faced in action 2. 3. Emission tests successful, only the emission of selenium from the artistic glass at 1100°C exceed the Legislation limit. However, the artistic glass contents of the mixtures to be foamed will be around 10% and very far from the conditions that can exceed the selenium emission limit. 4. The tests on ionic desorption in water of selected waste glasses was satisfactory.</td>
<td>Expected results achieved</td>
</tr>
<tr>
<td><strong>Action 2</strong>&lt;br&gt;Preparation of starting glasses</td>
<td>1. Production of special treated glass, suitable in its chemical and physical characteristics to be used as basis for the following production of the glass foam. 2. Production of 150 ton special treated glass)</td>
<td>1. Chemical and physical characteristics satisfactory: 2. Sufficient starting glasses (150 ton) were prepared within the set timeframe. 3. Residual inorganic and organic contents in the final powders,</td>
<td>Expected results achieved</td>
</tr>
</tbody>
</table>
### Action 3
Preparation of glass based cellular materials on laboratory scale

1. To obtain different glass foams that: 1) privileges the characteristics of mechanical resistance and of fireproof above the density and thermal insulation; 2) privileges the characteristics of thermal insulation above the mechanical characteristics; 3), overall characteristics are a perfect compromise between the various required characteristics.
2. Optimal physical characteristics of the foam
3. Acceptable costs of additives and unitary energetic costs

1. Emphasis has been laid on 1) and 2), in view of best application opportunities and thus market demand.
2. Achieved with:
   - glass powder composition: 85% soda lime glass rejects; 5 % front monitor glass rejects; 5% fiber glass rejects and 5 % of a mixture of lamp and artistic glass rejects;
   - Reducing agent Silicon Carbide 2% on weight on the mixture
   - Oxidation coadjutor CaSO4 0.5% on weight on the mixture
   - Reaction temperatures 900°C
   - Time 20 minutes
3. Achieved by methodology indicated under 2

### Action 4
Creation of pilot installation and experimental production of granules and blocks

1. Pilot plant ready by July 2010
2. Production of glass foam will amount to 750m³, by consuming 150 ton of special glasses
3. Physical characteristics of the foam equal or better than existing market products
4. Production costs improved compared to the existing market products.

1. Pilot installation ready by 30/07/2010, but breaking unit revised due to problems in action 5, finalized by summer 2011.
2. Amount of glass foam produced and 150 ton of special glasses consumed (part of which used in the building of action 5, other part for trials).
3. Result obtained with following mixture: 85% of Soda lime glass rejects, 5% of front monitor glass rejects from televisions; 5% of fibre glass waste; 5% of mixture of 50 % glass rejects from exhausted lamps and 50 % artistic glass rejects.
4. According to the competitiveness assessment, operation with a plant 4 times as big as the pilot plant

Expected results were good enough to proceed with implementation of the pilot level. The found technical parameters offered sufficient information for pilot plant design and trials.
(100,000 m\(^3\)) p/y would lead to a production price of 43.60 €/m\(^3\), against a current market price of normal glass foam of about 50 €/m\(^3\). A plant 8 times as big (200,000 m\(^3\)) would lead to a production price of 38.60 €.

<table>
<thead>
<tr>
<th>Action 5 Constr. of Civil Building made with light concrete based on glass foam</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A building with 250m2, 3 different levels, 6 office rooms and a meeting room, capable of demonstrating:</td>
</tr>
<tr>
<td>2. The use of a light structural concrete with medium density, and inserting as inert a glass foam with a cell-like structure with micro porosity, sustained by a light arcade, covered with 160 m2 of photovoltaic panels.</td>
</tr>
<tr>
<td>3. The use of a very light structural concrete, with low density and by inserting as inert a glass foam with a cell-like structure with medium porosity</td>
</tr>
<tr>
<td>4. 160 m2 of photovoltaic panels</td>
</tr>
<tr>
<td>5. Building autonomous in its energy production.</td>
</tr>
<tr>
<td>1. A building with a surface of about 300 M(^2), in three different levels, with n°6 office rooms and a meeting room. The building has been concluded as far as its casting and floors concern, and will be finalised by spring 2013.</td>
</tr>
<tr>
<td>2. For the floors and roof use of a light structural concrete with medium density, and inserting as inert a glass foam with a cell-like structure with micro porosity.</td>
</tr>
<tr>
<td>3. For the wall use of a very light concrete, with low density and by inserting as inert a glass foam with a cell-like structure with medium porosity and very high insulating capacity.</td>
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<tr>
<td>4. Instead to the previous solution with a roof covered by normal photovoltaic panel, a very important innovation was applied: to install a big arc in steel with a mobile high efficiency photovoltaic panel that is moving in two ways, rotation and translation, to optimise energy production and shadow needs during the day. 50 m2 of photovoltaic is sufficient in this way.</td>
</tr>
<tr>
<td>5. LCA evinced achievement of energy autonomy, as well as full recyclability of glass foam compounds at end of life. Though, the energy performance should be verified after completion of the construction.</td>
</tr>
</tbody>
</table>

Extra: 80% of the materials used for the building are recycled. Performance assets are expected to be achieved. Additional results improve the ecological performance of the building: complete recyclability at end of life of glass foam components and 80% of the building constructed with recycled materials.
5.3 Analysis of long-term benefits

5.3.1 Environmental benefits

Direct / quantitative environmental benefits

- For the construction of the demonstration building 80,000 kilo of previously unrecyclable glass has been used, composed of 85 % soda lime glass rejects; 5 % front monitor glass rejects; 5% fiber glass rejects and 5 % of a mixture of lamp and artistic glass rejects. All this material would have otherwise been landfilled. This applies as well to the soda lime glass component, as rejects have been used from the normal soda lime glass treatment process performed in Sasil (and developed in the MEIGLASS project).

- High amounts of primary resources have been saved in the construction of the demonstration building, on the one hand due to the project activities itself, on the other hand due to the application of other technologies developed by Sasil:
  - 400 m$^3$ of primary materials have been saved which should otherwise have been excavated: it concerns 80 % of the external casting (the walls), 50 % of the floors and roof, and 100 % of the insulating and draining substratum.
  - 80 % of the building as a whole is constructed from recycled materials. Apart from the glass foam lightened concrete and glass foam insulating substratum, it concerns:
    - 250 m$^2$ of tiles with base dough containing recycled glass treated by SASISL;
    - 200 m$^2$ of artificial mineral wool made with dough produced with various waste materials processed at the SASIL plant (roof insulation);
    - 50 m$^2$ of photovoltaic panels, whose ultra-clear glass was produced from recovered quartz, with high purity silica provided by SASIL to a flat glass factory specializes in the production of glass for solar panels.

- Reduction of energy consumption performed by the demonstration building is expected to be 100 %, but should be measured after its finalisation and after passing a winter season. Generally spoken, energy saving by use of the glass foam products referred to an average request of 15 kWh/m$^2$/year depends on the specific use made of the glass foam:
  - The foam used as insulating substratum offers a benefit of 30 kWh/m$^2$/anno;
  - The foam used as inert in lightened insulating concrete, offers a benefit of 100 kWh/m$^2$/anno.

- Further soda lime glass has been recycled – outside of the project - in the promotional production of foam glass for insulating substrates, amounting to 11,000 $m^3$, with the aim to present the product on the Italian market. This promotional production could not concern foam glass for lightened concrete production, as for this the breaking plant had to be modified. It was neither possible to carry out this promotional action with special glass rejects, as the preparation of starting glass from these rejects with the low dimensioned pilot plant would have meant a loss as prices had to be kept in this phase highly promotional. Due to the strong crisis in the building sector the production was interrupted in 2012.
As far as the direct benefits of the sensibilisation and dissemination activities concern, no precise analyses has been made to verify if investments in ecologic and energy efficient building increased during last years. However, due to legislation environmental requirements to the building sector have been increased, which is surely leading to better performances. In view of the economic crisis though, the possibility to have in the future cheaper materials to achieve high energy savings will surely contribute.

Relevance for environmentally significant issues or policy areas

The achievements are highly relevance for environmentally significant issues and policies:

- They show a viable technology to withdraw from landfilling special glass rejects until now not recyclable, which amount is expected to increase in the future (especially monitor and fiber glass);
- They show the future availability on the market of glass based insulation materials, produced from actually unrecyclable glass rejects, which allows to decrease significantly their price. This material has a performance in terms of resistance, safety and reversibility which is much higher than the commonly used polyurethane, insulation material which requires scarce petroleum resources. These advantages will become accessible for a large public thanks to the demonstrated technology.
- As far as the sensibilisation campaign concerned, it clearly awakened consciousness amongst citizens on ecological building issues. Most important appeared though, as we learned during the years, the increase of awareness and information amongst professionals of the building sector, which result to be the real vehicles for market spreading of eco-compatible and energy efficient technologies and materials and – as the performed study evinced – were not sufficiently prepared. Thus the availability of a still active supporting structure and the network of all stakeholders are considered by the Province of Biella important pillars of their environmental policy.

Foresaid achievements impact mainly on three distinct policy areas:

- Waste, offering a substantial contribution to implementation of the Thematic Strategy on the prevention and recycling of waste and the Waste Directive, by offering waste recycling technologies but as well new building materials which can be integrally recycled at end-of-life.
- Resources preservation, contributing to the implementation of the Thematic Strategy on the Sustainable Use of Natural Resources, by offering secondary raw materials to the most natural resource intensive sector in the world, the building sector.
- Energy and climate change strategy, contributing directly to energy savings in the building sector, which accounts for over 40% of the EU’s final energy demand and is a major source of greenhouse-gas emissions, making energy-savings there a key element of the European climate change strategy. The achievements may contribute directly to implementation of the Directive on energy end-use efficiency and energy services and the Energy Performance of Buildings Directive (EPBD) and indirectly as well to the EU’s 2020 and 2050 targets for cutting CO2 emissions.

5.3.2 Long-term sustainability

Qualitative environmental benefits

The demonstrated environmental benefits of the developed technology may have a wide impact on the long-term.
On an impact level, the Italian market should be able to consume 360,000 ton of until now unrecyclable glass rejects (= 1,800,000 m$^3$ of glass foam), of which 306,000 ton rejects from treatment of soda lime glass and 54,000 ton of front monitor glass rejects from televisions; fibre glass waste; glass rejects from exhausted lamps and artistic glass rejects. This would permit the full recovery of foresaid special glass rejects, once the product would be sufficiently introduced on the market, implying an important reduction in landfilling.

The expected benefits in terms of energy saving by use of the glass foam products referred to an average request of 15 kWh/m²/year depends on the specific use made of the glass foam:

- The foam used as insulating substratum offers a benefit of 30 kWh/m²/anno;
- The foam used as inert in lightened insulating concrete, offers a benefit of 100 kWh/m²/anno.

The certification of the new product on European level, the broad dissemination activities (local as well as international), the liaisons established with stakeholders of the building industry in several provinces and the first market introduction performed by Sasil will certainly fasten the achievement of foresaid impacts, although the severe crisis of the building sector should be taken into account as well as reluctance towards new materials amongst building companies.

**Economic benefits**

Long-term costs savings can be obtained by two end-user groups: on the one hand the producers of special glass waste, who can avoid landfilling costs be conferring for lower costs the materials to treatment firms. On the other hand owners of buildings built with glass foam as insulating substrates and glass foam based lightened concrete, who will be able to save on their energy account. It is expected that the investment – with respect to no application of insulating technologies – can be regained within 10 years.

As far as business opportunities concern, within the project production costs as well as technical performance have been carefully benchmarked during all process steps against those of similar insulating products (glass foams made from normal soda lime glass and polymers). According to the last competitiveness assessment, based on pilot plant operation, a production with a plant 4 times as big as the pilot plant (100,000 m$^3$ p/y) would lead to a production price of 43,60 €/m$^3$, against a current market price of normal glass foam of about 50 €/m$^3$. A plant 8 times as big (200,000 m$^3$) would lead to a production price of 38,60 €. Very interesting business opportunities do thus exist.

However, it should be highlighted that the crisis in the building sector is not favorable to the introduction of a new product on the market: only in Italy, during 2011 the sector lost 25 % of its turnover while 2012 saw a further decrease of 20 %, meaning 40 % reduction with respect to 2010.

As explained above, SASIL initiated the promotional sale of soda lime glass foams for insulating substrates in 2011, in order to prepare the Italian market for this product which till now was not available, facilitating the future introduction of the same material made from the special glass rejects as soon as the breaking plant would have been suitably modified. In 2011 8,000 m$^3$ were produced, but in January 2012 still 5,000 m$^3$ had not been sold, which implied the interruption of the production. By September 2012 only a further 3,000 m$^3$ had been sold.

The commercial organisation has now been enforced as to pursue a more incisive market penetration. Commercial agreements, until now only established with the Swiss firm Misaport with which a joint venture has been created for commercialisation, have been taken up now as
well with other European firms who sell glass foam in Italy made from normal glass rejects, proposing our special glass rejects foam.

Forthcoming investments regard the optimisation of the crushing unit to minimise the smallest particles during the preparation of the suitable particle size of the foam to be employed in the lightened concrete, which is considered the most fruitful employment of the product.

However, as long as the actual furnace used for production of insulating substrates cannot be employed at its highest potential and the breakeven point is not achieved (until now passive), industrial expansion of the plant cannot be foreseen.

Social benefits

The pilot plant for the production of glass foam employs actually 2 persons full time and 3 persons part time who cover the night and weekend turns. Realisation of an industrial plant, 4 times as big, would not lead to a linear multiplication of necessary labour force, however an additional 2-3 persons would surely be needed. As soon as the market would permit a plant with a capacity of 200.000 m³, at least other 2 persons would be needed.

Further long-term social benefits are obviously concerned with reduced landfilling and excavation, preserving landscapes; and with reduced emissions due to energy consumption adding to health benefits.

5.3.3 Replicability, demonstration, transferability, cooperation

Most business and market related aspects of these issues have been above outlined under ‘economic long-term sustainability’.

During the project, the developed activities led to an expression of interest from Casa Clima consultants of Novara Province, which would like to introduce the glass foam within their territory and in the Province of Verbano, Cusio and Ossola, where architects and building industry is very aware of eco-building. Casa Clima is an agency 100 % owned by Bolzano Province, engaged in building energy certification on the entire Italian territory and delivery of training and awareness raising activities.

As far as replicability regards, the technology is not easy to be transferred to other industrial plants, as only treatment of huge amounts of glass rejects make the preparation of starting glasses cost-effective. Indeed, SASIL used parts of its normal installations for this task.

Opportunities are nowadays assessed to expand sales to neighbouring countries like Switzerland, but this requires an important marketing approach to make the particular composition of the foams desirable compared to normal glass foam. A marketing campaign is planned, based on the outcomes of performance monitoring of the demonstration building which will start after May 2013. It is expected that these results will make a difference with respect to what can be shown to potential clients today.

5.3.4 Innovation and demonstration value

The technology developed in the NOVEDI project could not have been realised without the financial support of the LIFE programme, which shared with Sasil the high investments which were necessary to achieve the required results. The same applies to the huge sensibilisation and dissemination campaign performed by the Province of Biella.
Moreover, the LIFE programme provided an important channel to publish the innovations achieved on a national as well as European scale. It is expected that this will be even more evident now the project has been finalised and the layman’s report will soon be available at the LIFE programme’s website, as well as on Sasil and Province of Biella’s websites.

### 5.3.5 Long term indicators of the project success

Long term indicators for project success can be identified as follows:

- achievement of full potential of one furnace, recovering 4,000 ton/year of previously unrecyclable glass rejects and producing 20,000 m³ of glass foam;
- market share with respect to traditional insulation materials used in the building sector: SASIL foresees, within 2014, to sell at least in Italy 20,000 m³/year of glass foam, about 5% of the volume actually consumed in polyurethane, rockwool and glass wool.
- % of special glass rejects which consumed by the production of glass foam.
5.4. Dissemination issues

5.4.1 Objectives

The action dedicated to dissemination and sensibilisation, had the specific objective to increase the interest of the construction sector and citizens to provide new and retrofitted buildings with eco-compatible insulation materials in order to reduce energy consumption, in particular with glass-based insulation materials, as to assure a future sufficient market demand for the effective recycling of all glass rejects actually landfilled in North Italy.

The following target groups were identified:
Construction sector of North Italy
Citizens of the Province of Biella
Italian Public authorities and their waste treatment firms
International stakeholders, like European public authorities, waste treatment agencies, construction firms and those specialised in concrete production, architects and civil engineers, and European union representatives

The following main results where attended (synthesis):
- realisation of a provincial financial support instrument
- 1 information campaign towards citizens in the Province of Biella and in Northern Italy on both the technologies and the financial instrument
- 2 informative meetings with stakeholders of the construction sector
- informative actions towards other Public Authorities
- final international conference for experts of the construction, waste treatment and energy sectors, as well as public authorities

5.4.2 Dissemination: overview per activity

Activities carried out

Action 6: Sensibilisation and dissemination of the results towards construction sector, citizens and public sector (01/06/2009-30/06/2011)

Start-up
The activities kicked off with a first coordination meeting between the partners organised on the 1\textsuperscript{st} of July 2009. Thereupon, the Province of Biella drafted a first version of the Dissemination and Communication plan, agreed upon with Sasil SpA.
In August 2009 the project was presented for the first time to a large public by Telebiella, local broadcaster: they filmed and broadcasted in the News bulletin a visit of Province of Biella assessors for Environment and for Technological Innovation to the Sasil plant, at the 6th of August 2009 (see \url{http://www.provincia.biella.it/on-line/Home/Progetti/Novedi-NOVEtroidLiscarica/FilmatieMultimedia/articolo5458.html}).
Shortly after, a leaflet on the project was prepared, which was published in 2,500 copies by the beginning of October 2009.
Building sector stakeholders information and networking
First activities were aimed at informing the stakeholders of the building sector on the NOVEDI objectives, discussing the approach to be followed with them and setting up a dedicated network. They were launched by a presentation to representatives of the building industry, at the Sala Becchia of the Province of Biella on the 19th of October 2009. All representative organisations were present: collegio costruttori edili, ordine degli architetti, ordine degli ingegneri, collegio dei periti edili, collegio dei geometri, and craft associations. 22 Representatives participated to the event which lasted half a day. Moreover, 50 people followed the event on the web, where it was published in streaming.
A series of meetings with the sector representative organizations led to the signature of a Memorandum of Understanding on the 24th of September 2010, aimed at the establishment of a long-term platform for collaboration, and in particular the joint realization of an energy desk. It was signed by the following entities:
- Province of Biella
- Ener.BIT S.r.l., (realisation of the desk)
- L’Associazione Piccole Imprese Biella – API Biella (small enterprises association)
- Il Collegio dei Costruttori Edili della Provincia di Biella (construction sector)
- Il Collegio dei Geometri e Geometri Laureati della Provincia di Biella
- Il Collegio dei Periti Industriali e dei Periti Industriali Laureati delle Province di Biella e Vercelli
- Confartigianato Biella
- Cna Biella
- L’Ordine Professionale degli Architetti di Biella
- L’Ordine Professionale degli Ingegneri di Biella
- L’Unione Industriale Biellese – UIB

Feasibility study
Shortly after project start it became clear that the creation of an own financial support instrument, as proposed in the project, would not offer any added value to meanwhile improved national and regional schemes, but that lack of awareness and knowledge should be tackled.
The Province acknowledged that with regard to energy efficient building a too dispersive and generic information supply existed within its territory. Therefore, it intended to plan its activities around the creation of an info-point (physically financed by other resources), capable of supplying precise and clear information to citizens and professionals of the building sector. Also in view of the new Regional legislation, named ’Piano Casa’ (2009), which introduced facilitations for energy efficient and ecologic building, clear information on technical solutions and the legal framework would improve the use of the available technologies and opportunities and thus the impact in terms of energy savings and reduction of atmospheric emissions. The info-point could be managed by Enerbit, entity owned by the Province and the Province’s Municipalities dedicated to energy issues. The feasibility study foreseen in the project was therefore tailored to the need of identifying the information to be supplied and the methodologies to be followed.
In December 2009 a contract was assigned to Enerbit Srl. for the realization of the feasibility study, concluded on 30/04/2010. The contractor acquired information on the situation and needs in the Province’s territory by means of the distribution of three types of questionairies for three different target groups:
- Local public authorities: all technical offices of the Municipalities were involved, facilitated by an invitation to participate to the survey sent by the Province. These data constituted the data base by which to measure the knowledge and support mechanisms existing in the Province on energy issues.
- Private citizens
- Enterprises
The latter two questionnaires were published on line at http://www.provincia.biella.it/online/Home/Progetti/Novedi-NOVEtroinDiscarica/QuestionarieAnalisi.html. The page concerned received until the end of March 2010 yet more than 1.000 web accesses. The feasibility study (Annex 10) is composed of the results of the questionnaires to citizens, to enterprises and to local authorities; a synthesis of the overall results and a Vademecum. The final synthesis has been translated in English and reports on the ‘Analyses of use, degree of knowledge and informative needs of citizens, enterprises and local authorities’, while the Vademecum is a document able to directly satisfy part of these needs.

Energy Desk
On the 2nd of December 2010 the Energy Desk (Sportello Energia) was opened. The desk has been created in synergy with the sector representative organizations, according to foresaid Memorandum of Understanding signed on the 24th of September 2010.

The Desk was set up according to the findings of the feasibility study, with the intention to support citizens, enterprises and professionals in all aspects of energy efficient building and renewable energy. It provides for physical and virtual access:
- A virtual desk has been created on line at the website www.novedi.it, (realised by the firm Ariadne). The operation of the service has been subcontracted to Enerbit S.p.A., a firm controlled by the Province of Biella and owned by the same Province and local authorities.
- The physical Desk was created at the Provincial headquarter, with opening to the public on Monday from 15.30-17.30 and Thursday from 11.00-13.00. Physical and virtual Desk made use of a network of professionals, available to answer questions from citizens and enterprises.

It appeared soon, however, that the Desk in his physical form had too few contacts to justify its operation. Therefore it was closed yet by the end of February 2011 and front office tasks where delegated to the CNA and Confartigianato, which appeared more cost-effective. The virtual Desk is still managed by the Province and linked to the websites of foresaid associations.

In order to enforce the physical interaction with citizens, it was decided to go into the local territories to promote the issue face-to-face with them during local small scale meetings in various municipalities.

Information and sensibilisation towards building and glass recycling sectors
In 2009 and 2010 the following events were organized:
- Publication in streaming on the web of an event organized for representatives of the building industry (architects, craft, construction) at the Sala Becchia of the Province of Biella on 19/10/2009. 22 representatives of professional and sector associations participated to the event which lasted half a day. 50 people followed the event on the web.
- Presentation of the project to professionals of the Italian glass recycling industry, at the Sala Becchia of the Province of Biella on 19 March 2010. Ca. 40 participants from public and private entities assisted to the presentation which lasted half a day.
- Seminar dedicated to enterprises in the construction sector: "Il rimpiego degli scarti di vetro nell'edilizia" (the re-use of glass rejects in buildings), 14 May 2010 from 9.00 to 13.00 at the Provincial headquarter in Biella, Becchia hall, in collaboration with the ANCE Biella (National association of building sector). All enterprises of the sector in and around Biella have been invited, 35 representatives participated and the event could be followed in streaming from the Province’s website. At the Province’s NOVEDI website the program, the video and all presentations can be downloaded.
Information and sensibilisation campaign towards citizens

From November 2009 until end of 2011 the following activities were carried out to sensitize and inform citizens and enterprises of the Province:

- Presentation of the project in the Province’s stand at the fair “EXPO di autunno”, at Biella from 24/10/2009 to 1/11/2009.
- Participation to local manifestation ‘In Giardino’ on the 19th of September 2010: A day dedicated to sustainability and protection of environmental heritage, characterized by the themes renewable energy, energy saving, recycling and respect for the environment. Stands, laboratories and theater in town to inspire and inform citizens. A stand dedicated to the NOVEDI project took part in the event. (leaflet and picture in annex 23)
- Spring 2011: Information evenings: a series of meetings with citizens have been organised by the Province, in collaboration with Municipalities of the Province of Biella. Ener.bit Srl coordinated the organization and Sasil as well as all fore-mentioned representative organisations collaborated to the realisation. During the evenings the following items have been discussed:
  - Retrofitting and energetic requalification
  - Energy certifications
  - Financial support schemes and fiscal facilitations.
  - Sasil has presented the technological part of the NOVEDI project and the innovations brought in support of energy-efficient building.

The meetings took place from 21.00-23.00 in the following municipalities with the indicated number of participants:
- Cossato, 27/05/2011, 20 participants;
- Mongrando, 09/06/2011, 25 participants;
- Biella, 16/06/2011, ca. 20 participants;
- Trivero, 23/06/2011, 18 participants;
- Cavaglià, 07/07/2011, 24 participants;
- Adorno Micca, 14/07/2011, 12 participants;

At the page www.novedi.it a document has been published which has been presented during the meetings: Presentation ‘Save energy saving money’.

- Participation to local manifestation ‘InGiardino’ 18 September 2011. Like in 2010, a stand dedicated to the NOVEDI project took part in this event in Biella, managed by the Province with support of Sasil.
- Collaboration with Bona Institute in the framework of the Biella high school competition ‘Premio Biella letteratura e Industria’ 2012: students produced a short documentary on the project with interview of project leader Lodovico Ramon: http://youtu.be/V_NIURDgfhU.

Dissemination on national/international level towards public authorities, building sector and citizens:

- Presentation of the project at adjacent stands of the Province of Biella and Sasil at the Biella Fair Ecolife, on 20-21-22 November 2009, with a presentation on the 21st for about 20 interested stakeholders.
- Presentation of the project during the final conference of the project MEIGLASS, to which NOVEDI is considered a follow-up. The conference took place at Palazzo Boglietti in Biella, on the 19th of February 2010, and more than 100 participants took part.
- Presentation of the project at the Sasil stand at the fair EcoMondo, Rimini, from 28 to 31 October 2010.
• Joint NOVEDI stand at SAIE 2010, International Building Exhibition at Bologna, 27, 29 and 29 October 2010. A video on the project has been shown, which can be viewed at the NOVEDI website of the Province.

• Presentation of the project at the Manifestation Ecolife, 19-20-21 November 2010, by Province of Biella. Like in 2009, Province of Biella promoted the project with a stand at the Ecolife fair for citizens, dedicated to energy efficiency, recycling and reduction of harmful emissions. Pictures have been published on the Province’s portal.

• Manifestation Ecolife 18-19-20 November 2011. Like in 2009 and 2010, Province of Biella promoted the project with a stand at the Ecolife fair for citizens, dedicated to energy efficiency, recycling and reduction of harmful emissions. Pictures have been published on the Province’s portal.

• The final conference took place on the 25th of May 2012, for an audience of 61 participants mainly from the construction sector, education sector, and environmental agencies. The conference was entitled: Waste Recycling for eco-friendly building: results of NOVEDI project and future challenges. Simultaneous translation was available. A video of the conference was filmed and posted on the Province of Biella website: http://www.provincia.biella.it/on-line/Home/Inevidenza/Novedi-NOVEtromDiScarica/FilmaticMultimedia/articolo6641.html. An audio registration in English has been as well provided. A high-school class used the occasion to have students study the subject and make a film, which will take part in autumn in a students-competition and has been published on the web: http://youtu.be/V_NlURDgfhU.

Pictures and materials of many events are attached in annex 23.

Action 7. Obligatory dissemination actions: notice board, website and layman’s report (01/01/2009-30/06/2011)

By the end of March 2009 a notice board has been erased at the Sasil production plant in Brusnengo. At the Province the notice board has been installed once first activities were effectively started up, by November 2009.

The project website had been created within Sasil’s LIFE website. The direct address is: http://www.sasil-life.com/novedi.htm.

The Province of Biella created as well a website at the address www.novedi.it, which functions as well in support of the Energy Desk.

While the Sasil website keeps a more technical approach, the Province’s website targets a general public, supplying all kind of information on energy efficient and ecological building, publishing events and all dissemination materials. Obviously both websites are referring to each other.

The project website run by the Province of Biella, www.novedi.it, has totaled 7.406 visitors during the project.

The project website run by Sasil, www.sasil-life.com/novedi.htm, has totaled 885.773 accesses from 10.481 different visitors during the project. Especially from October 2010 onwards (i.e. from the SAIE exposition), around the information evenings in spring 2011, and around the final conference, visitors increased exponentially from not even 10 monthly until 590 visits in a month.

The layman’s report was prepared after formal project conclusion, as it was preferred to have evidence of the completion of all glass foam applications in the demonstration building. It will be updated in summer 2013 once the building is finalized and its energy performance assessed. Therefore, it will be so far only widely diffused in electronic form, while paper copies will distributed once the final version will be available.
*Problems encountered and solutions found*

**Action 6:**
A small delay occurred in start-up of the sensibilisation and dissemination activities, caused by the elections and consequent changes in the Province’s management, solved by of July 2009. The interest to the dissemination events was satisfactory and in line with the expectations. However, participants came in particular from the northern Italian regions. The information on the website, where all the presentations are published, should enable to reach as well stakeholders from other regions. Moreover, the participation to fairs were aimed at the same goal to reach stakeholders from the whole of Italy and abroad. The final conference foresaw simultaneous translation, but no foreigners subscribed, notwithstanding publication of the event at the LIFE 20th anniversary website and direct mailing to all European representative organizations from the building and glass treatment sector. It was then decided to provide an audio registration in English of the presentations, as to permit access to these target groups.

The results of the physical Energy Desk were quit disappointing due to lack of citizens’ use of the desk. The service has thus be transferred to desks within the CNA and confartigianati addressing also other users requirements, and has been completed with a series of Information evenings in the various municipalities for citizens, which resulted much more responding to citizens’ needs.

A presentation of project results could so far not be hosted by the ATIV congresses as not being in line with the themes of the past years. The ATIV Congress 2013, to be held in Parma in autumn, will probably focus glass in the building sector/architecture, framework in which such a presentation would be highly suitable.

**Action 7:**
Improvement of the websites encountered some difficulties due to the initial design. The actual presentation is considered satisfying by the project partners. Province of Biella added a page on the project in English. Due to the essentially local character of the activities carried out by the Province, it is not really feasible and neither seems useful to translate all the pages on the various activities as well in English. The lead partner’s website should cover this gap, as being more oriented to a European public interested in the demonstrated technology.

*Achievement of results and objectives*

The following table offers a comparison to the expected and achieved results:

<table>
<thead>
<tr>
<th>Action</th>
<th>Results foreseen</th>
<th>Results achieved</th>
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<tr>
<td>Act.6-Sensibilisation and dissemination of the results towards construction sector, citizens and public sector</td>
<td>1. Information campaign towards citizens of Biella Province 2. 2500 leaflets on the project; 3. 2500 brochures on the project’s results; 4. Publication of the project on the Province of Biella website 5. Collaboration with the local television TV Biella to inform citizens on the project 6. a 7-days information-stand at a local festival</td>
<td>1. Information campaign implemented: 2. 2.500 Leaflets produced and distributed 4. Dedicated website linked to energy desk: - More than 7.400 web contacts generated by the Province’s NOVEDI website. 5. Local television TeleBiella broadcasting on start up of the project and several events 6. 7-day info stand at local fair ‘Expo di autunno 2009: 2 times stand at local manifestation ‘InGiardino, 2010 and 2011. 7. 6 local info meetings for citizens, 119 participants.</td>
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7. one or two local information meetings towards citizens about energy efficient building. Expected audience: 50-80 persons
8. feasibility study on the introduction of public financial support instruments for enhancing energy-efficient building
9. one-day informative meeting addressed to stakeholders of the building sector in Italy. Expected audience: 80 enterprises
10. one-day informative meeting to glass treatment and recycling industries in Italy. Expected audience: at least 40
11. Promotion of the project on the International Building Exhibition SAIE
12. Presentation of the new product at exhibitions, conferences and other events in Europe.
13. 2 articles to be published in dedicated reviews
14. one-day international conference for an audience of at least 80 100 stakeholders of the building sector in Europe.
15. inauguration of the demonstration building.

8. 1 study for assessment of user needs to enhance energy-efficient and ecological building
9. - 1 meeting for building sector with 22 representatives, followed in streaming by other 50 target group members.
- 1 Seminar dedicated to enterprises in the construction sector: "Il reimpiego degli scarti di vetro nell'edilizia" (the re-use of glass rejects in buildings), all Provincial enterprises invited, 35 participants and web publication in streaming.
10. Informative meeting to Italian glass recycling industry. 40 Participants from public and private entities, 630 invitations sent
11. Promotion at SAIE International Building Exhibition 2010
13. many articles published in local newspapers, 1 in Glass World Wide magazine
14. one-day conference, 61 Italian participants
15. foreseen in spring 2013

Other:
- 1.000 direct feedback from citizens (private and business) by web-questionnaires.
- Network established with the building sector on energy-efficient building, memorandum of understanding signed by 9 associations, Enerbit and the Province.
- Entire building sector in Province of Biella informed by activities jointly carried out with their representative organisations.
- Realization of Energy Desk.
- Sensibilisation of high school students participating to final conference and producing a short film.

Act.7-
Obligatory dissemination actions: notice board, website and layman’s report

1. Notice board
2. Project website, 365 visitors yearly expected
3. Layman’s report

1. Notice board at Sasil’s production plant in place by March 2009; at Province November 2009.
2. 2 Project-websites created, totaling 17.887 visitors in 3,5 years, i.e. 5.110 per year, 14 times what had been expected.
3. Layman’s report in 1st edition delivered in October 2012, in final expected by summer 2013 due to delay in action 5 conclusion.
Evaluation of achieved objectives

The main objective to increase knowledge and sensibility amongst citizens has been achieved in the Province of Biella. The same can be said for the north Italian construction sector. It was yet clear from project start that the creation of another financial support scheme on behalf of the Province would not supply added value to the schemes created on national and regional level between the presentation of the project and its start. Instead, main bottleneck for huge market uptake of such building techniques was identified in a lack of information, not only amongst citizens but also amongst construction firms and architects. The feasibility study thus focused on how this problem could be best faced and what were the most critical gaps to be bridged. The networking approach adopted by the Province resulted very successful: the entire construction sector has been informed with the involvement of their own representation bodies, and the network is still in place. During the project it became evident that most important vehicle for large market introduction of energy efficient building technologies are the professionals of the building sector, who should be made capable of advising their clients and aware of existing technologies and their advantages in terms of energy saving.

The differentiated methodology followed, to be implemented in collaboration with all stakeholders, to sensitize and inform citizens, by institution of an energy desk (physical and web-based), creation of a vademecum, huge presence at local manifestations with information stands, small scale information meetings spread over the territory and large involvement of local newspapers appeared to be successful. In particular the vademecum was considered very useful and the other activities saw a significant number of citizens becoming aware. It should be said that the energy desk didn’t have the expected success, showing low numbers of visitors both at the office and on the website, probably highly influenced by the economic crisis which discourage citizens to invest in their houses. However, most citizens of Biella have heard of the initiative.

On an impact level, investments in photovoltaic panels have increased during last years, although this tendency is expected to slow down as financial schemes are planned to be cut. Also energy efficiency of buildings is increasing, due to governmental legislation, availability of new technologies and the better information supply.

On the international level, dissemination results were scarce: this should be countered however with forthcoming larger diffusion of the results by Sasil once the demonstration building is ready. The performance results of this building will be most important to convince potential distributors and clients to invest in the developed glass foam made from until now unrecyclable glass rejects, leveraging a general approach towards energy efficient building.

Completed deliverables

Action 6:
Supplied with Inception report, hereby in electronic copy:

- Presentation at LIFE+ 2009 kick off meeting in Rome, 3rd March 2009 (Annex 10, electronically)
- Technical presentation NOVEDI (annex 11)
- Dissemination & Communication Plan 1° edition (annex 12)
- Press articles on the project (annex 13)
- Article on the GWW (Glass World Wide) Magazine (annex 14)
- Video registration of the interview with the Assessor for Environment of the Province of Biella Mr. Fausto Governato and director of Sasil SpA Mr. Vico Ramon, 06/08/2009, on www.novedi.it (annex 27, CD-Rom)
Supplied with mid-term report, hereby in electronic copy:

- Deliverable Action 6: General leaflet on the project (annex 15)
- Programme event 19\textsuperscript{th} of October 2009 (annex 16)
- Programme event 19\textsuperscript{th} of March 2010 (annex 17)
- Invitation letter event 14\textsuperscript{th} of May 2010 (annex 18)
- Programme event 14\textsuperscript{th} of May 2010 (annex 19)
- Questionnaire for public authorities (annex 20)
- Press articles: article in Eco of Biella 22/10/2009; in Eco of Biella 19/11/2009; in La Stampa 14/03/2010; in Il Biellese (annex 21)
- The questionnaires for citizens and enterprises are to be found on the website www.novedi.it (direct link: http://www.provincia.biella.it/on-line/Home/Progetti/Novedi-NOVENTroinDIscarica/QuestionarieAnalisi.html).
- The presentations held on the various events can be found on the website www.novedi.it (direct link: http://www.provincia.biella.it/on-line/Home/Progetti/Novedi-NOVENTroinDIscarica/docCat.999.1.25.1.2.html).
- The interview with the Assessor for Environment of the Province of Biella Mr. Fausto Governato and director of Sasil SpA Mr. Vico Ramon can be found on the website www.novedi.it (direct link: http://www.provincia.biella.it/on-line/Home/Progetti/Novedi-NOVENTroinDIscarica/artCatFilmatieMultimedia.1096.1.25.7.2.html).

Supplied with progress report, hereby in electronic copy:

- Feasibility study, The study is composed of several analyses and a synthesis in Italian and English. Moreover it comprises a Vademecum put at disposal of the target groups (annex 22)
- Variety of flyers, leaflets, totem, posters and photographs of participation to fairs (annex 23)
- Video registration of film diffused at SAIE International Building Exposition 27-30 October 2010 (annex 28, also on www.novedi.it)
- Video registration of one of the local information meetings with citizens 16/06/2011, Biella (annex 29, also on www.novedi.it)
- Available on www.novedi.it: Video registration of the seminar targeting the building sector ‘the re-use of glass rejects in buildings’ of 14/05/2010

Supplied with final report, hereby in electronic and paper copy:

- Deliverable Action 6: Final conference proceedings (Programme and presentations) (annex 24)
- Video registration of final conference 25/05/2012, part 1 and 2 (annex 25, CD-Rom)
- Audio registration in English of final conference (annex 26, CD-Rom)

Action 7:
- Project notice board
- Website online. Address: www.sasil-life.com/novedi.htm and www.provincia.biella.it/on-line/Home/Progetti/Novedi-NOVENTroinDIscarica.html
- Layman’s report in Italian (annex 30) and in English (annex 31), attached in paper and electronic copy.

Final report LIFE07 ENV/IT/361 NOVEDI

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5.4.2 **Layman's report**

The Layman’s report is hereby attached in Italian and English version. As the project has not yet completed all its activities, intention is to release an update of the layman’s report by summer 2013, as to report the final performance data on the demonstrative building.
5.4.3 After-LIFE Communication plan

Sasil

Sasil’s intention is to exploit the achieved results in forthcoming years by industrializing the developed production process. On an impact level, the Italian market should be able to consume 360,000 ton of until now unrecyclable glass rejects (= 1,800,000 m$^3$ of glass foam), of which 306,000 ton rejects from treatment of soda lime glass and 54,000 ton of front monitor glass rejects from televisions; fibre glass waste; glass rejects from exhausted lamps and artistic glass rejects. This would permit the full recovery of foresaid special glass rejects, once the product would be sufficiently introduced on the market, implying an important reduction in landfilling.

Sasil yet started during the project to produce and sell unbroken glass foam to be used as insulating and draining substratum for promotional purposes, in order to prepare the Italian market for this product which till now was not available. This activity was meant to facilitate the future introduction of the glass foam made from special glass rejects, and its broken form to be used in lightened concrete, as soon as the breaking plant would have been suitably modified. Notwithstanding the operation with the too small dimensioned pilot plant, not using special glass rejects allowed to sell the material for a competitive price which is equal to the direct production costs, as yet reported in the request for amendment of the 29th of March 2011.

In 2011 8,000 m$^3$ were produced, but in January 2012 still 5,000 m$^3$ had not been sold, which implied the interruption of the production. By September 2012 only a further 3,000 m$^3$ had been sold, leaving still leaving 2,000 m$^3$ in the deposit, forcing Sasil to interrupt the production.

The lower market interest than expected is directly to be explained by the severe crisis in the building sector, which is not favorable to the introduction of a new product on the market: only in Italy, during 2011 the sector lost 25% of its turnover while 2012 saw a further decrease of 20%, meaning 40% reduction with respect to 2010.

Sasil is faithful that once the performance indicators will be available of the demonstration building a better presentation of the product can be made and thus market penetration can be facilitated. Meanwhile the following activities are ongoing and planned:

* In collaboration with Misapor, with which a joint venture has been created for actual commercialization of glass foam for insulating substrates and future for glass foam for lightened concrete, an illustrative brochure has been realized which explains the large variety of use modalities of the glass foam, with indication of the technical characteristics of the product (see also the presentation of Misapor during the final conference).

* The commercial organisation has been enforced as to pursue a more incisive market penetration. Sasil subscribed to an internet site where information can be obtained on all authorized building projects in north Italy, in order to be able to contact the involved firms and present the new product to them. Commercial agreements, until now only established with the Swiss firm Misapor with which a joint venture has been created for commercialisation, have been taken up now as well with other firms who sell glass foam in Italy made from normal glass rejects, proposing our special glass rejects foam. The product has been presented to 4 distributors which are now organizing seminars in 4 different geographic areas of Italy: north-west, centre-north, north-east, and south.

* Agreements have been taken with a local producer of concrete, which intend to make 2 silos available for storage of the two types of glass foam to be used in insulating lightened concrete and
structural lightened concrete. His intention is to apply the materials contributing thus to further diffusion of this most challenging application of glass foam.

* Forthcoming investments regard the optimisation of the crushing unit to minimise the smallest particles during the preparation of the suitable particle size of the foam to be employed in the lightened concrete, which is considered the most fruitful employment of the product. However, as long as the actual furnace cannot be employed at its highest potential and the breakeven point is not achieved (until now passive), industrial expansion of the plant cannot be foreseen.

* Expression of interest received during the project from Casa Clima consultants of Novara Province, which would like to introduce the glass foam within their territory and in the Province of Verbano, Cusio and Ossola will be exploring possible ways of collaboration. Casa Clima is an agency 100 % owned by Bolzano Province, engaged in building energy certification on the entire Italian territory and delivery of training and awareness raising activities.

* Opportunities are assessed to expand sales to neighbouring countries like Switzerland, but this requires an important marketing approach to make the particular composition of the foams desirable compared to normal glass foam. A marketing campaign is planned, based on the outcomes of performance monitoring of the demonstration building which will start after May 2013. It is expected that these results will make a difference with respect to what can be shown to potential clients today.

* Intention is to organize in the future deposits at building material outlets, to be paid after sale, as to promote the use of glass foam in big-bags for restructuration and retrofitting purposes.

* Sasil’s meeting room at the production plant will be used to meetings with building companies, civil engineers and architects, to present the foam glass product and its potential applications, offering examples on site.

* Experimentations are foreseen together with prefab producers, to assess the possibility of introducing glass foam in these prefabs, as to open new markets. The sector knows applications in residential as well as industrial building.

* Next year, once performance results have been achieved, Sasil with support of its consultants Mr. Piero Ercole and Paolo Bertuzzi, intends to try to present the final results on European congresses of the glass and building sector, as to inform the community on the achievements and enhance a wider market uptake.

**Province of Biella**

Fortunately, in order to guarantee future sustainability, Province of Biella transferred the Energy desk to sector representatives, keeping in place the portal at its own website. The created network of building sector stakeholders is intended to remain in place as well as to join efforts to stimulate energy efficient building. These choices today result particularly smart, as Province of Biella will not be able to carry out further specific activities on the policy issue in the near future, as it is suffering severe budget cuts, which are making even core-tasks difficult to be assured to the citizens. Moreover, it is expected that in forthcoming year the Province should merge with a neighbouring Province, which means further uncertainty of the possibilities to actively involve in the topic which is so much cared about by the Province.
6. Comments on the financial report

6.1 Costs incurred

In the following tables the expenditures levels are reported, respectively for total costs and for eligible costs. The amounts have been rounded to the nearest 1 €. Precise figures with decimals are shown in the attached financial report.

Total costs incurred

<table>
<thead>
<tr>
<th>Budget breakdown categories</th>
<th>Total cost according to the Commission’s decision*</th>
<th>Total costs incurred from the start date to 31/05/2012 in €</th>
<th>% incurred costs / foreseen costs per category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Personnel</td>
<td>570.528</td>
<td>559.079</td>
<td>97,99%</td>
</tr>
<tr>
<td>2. Travel and subsistence</td>
<td>11.600</td>
<td>1.634</td>
<td>14,09%</td>
</tr>
<tr>
<td>3. External assistance</td>
<td>383.960</td>
<td>347.053</td>
<td>90,39%</td>
</tr>
<tr>
<td>4. Durable goods</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infrastructure</td>
<td>53.000</td>
<td>52.570</td>
<td>99,19%</td>
</tr>
<tr>
<td>Equipment</td>
<td>1.330.000</td>
<td>1.456.612</td>
<td>109,52%</td>
</tr>
<tr>
<td>Prototype</td>
<td>640.000</td>
<td>528.450</td>
<td>82,57%</td>
</tr>
<tr>
<td>5. Land purchase / long-term lease</td>
<td>0</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>6. Consumables</td>
<td>83.000</td>
<td>43.224</td>
<td>52,08%</td>
</tr>
<tr>
<td>7. Other Costs</td>
<td>3.325</td>
<td>10.196</td>
<td>306,65%</td>
</tr>
<tr>
<td>8. Overheads</td>
<td>165.946,41</td>
<td>151.634</td>
<td>91,38%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3.241.359</td>
<td>3.150.453</td>
<td>97,20%</td>
</tr>
</tbody>
</table>
Total eligible costs incurred

<table>
<thead>
<tr>
<th>Budget breakdown categories</th>
<th>Total eligible cost according to the Commission's decision*</th>
<th>Eligible costs incurred from the start date to 31/05/2012 in €</th>
<th>% incurred eligible costs / foreseen costs per category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Personnel</td>
<td>570,528</td>
<td>559,079</td>
<td>97,99%</td>
</tr>
<tr>
<td>2. Travel and subsistence</td>
<td>11,600</td>
<td>1,634</td>
<td>14,09%</td>
</tr>
<tr>
<td>3. External assistance</td>
<td>383,960</td>
<td>347,053</td>
<td>90,39%</td>
</tr>
<tr>
<td>4. Durable goods</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infrastructure</td>
<td>13,250</td>
<td>13,143</td>
<td>99,19%</td>
</tr>
<tr>
<td>Equipment</td>
<td>665,000</td>
<td>663,421</td>
<td>99,76%</td>
</tr>
<tr>
<td>Prototype</td>
<td>640,000</td>
<td>528,450</td>
<td>82,57%</td>
</tr>
<tr>
<td>5. Land purchase / long-term lease</td>
<td>0</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>6. Consumables</td>
<td>83,000</td>
<td>43,224</td>
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</tr>
<tr>
<td>7. Other Costs</td>
<td>3,325</td>
<td>10,196</td>
<td>306,65%</td>
</tr>
<tr>
<td>8. Overheads</td>
<td>165,946,41</td>
<td>151,634</td>
<td>91,38%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2,536,609</td>
<td>2,317,834</td>
<td>91,38%</td>
</tr>
</tbody>
</table>

The direct costs incurred per action confronted with the foreseen costs per action are indicated in the table below:

<table>
<thead>
<tr>
<th>Action number and name</th>
<th>Expected costs</th>
<th>Direct costs incurred from the start date to 31/05/2012 in €</th>
<th>Under/overs pending</th>
<th>% Incurred direct cost / total costs per action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action 1 &quot;Characterisation of the materials involved&quot;</td>
<td>77,718</td>
<td>74,637</td>
<td>3,080</td>
<td>96,04%</td>
</tr>
<tr>
<td>Action 2 &quot;Preparation of starting glasses&quot;</td>
<td>530,249</td>
<td>526,230</td>
<td>4,019</td>
<td>99,24%</td>
</tr>
<tr>
<td>Action 3 &quot;Preparation of glass based cellular materials on laboratory scale&quot;</td>
<td>176,741</td>
<td>170,746</td>
<td>5,996</td>
<td>96,61%</td>
</tr>
<tr>
<td>Action 4 &quot;Creation of pilot installation and experimental production of granules and blocks&quot;</td>
<td>1,522,365</td>
<td>1,635,277</td>
<td>- 112,912</td>
<td>107,42%</td>
</tr>
<tr>
<td>Action 5 &quot;Construction of Civil Building made with light concrete based on glass foam&quot;</td>
<td>368,589</td>
<td>255,513</td>
<td>113,076</td>
<td>69,32%</td>
</tr>
<tr>
<td>Action 6 &quot; Sensibilisation and dissemination of the results towards construction sector, citizens and public sector&quot;</td>
<td>69.757</td>
<td>82.355</td>
<td>- 12.599</td>
<td>118.06%</td>
</tr>
<tr>
<td>Action 7 &quot; Obligatory dissemination actions: notice board, website and layman’s report &quot;</td>
<td>12.673</td>
<td>6.774</td>
<td>5.900</td>
<td>53.45%</td>
</tr>
<tr>
<td>Action 8 “Project management by the lead partner SASIL”</td>
<td>259.271</td>
<td>208.581</td>
<td>50.690</td>
<td>80.45%</td>
</tr>
<tr>
<td>Action 9 “Project management by the partner Province of Biella”</td>
<td>19.428</td>
<td>23.321</td>
<td>- 3.893</td>
<td>120.04%</td>
</tr>
<tr>
<td>Action 10 “Monitoring”</td>
<td>33.621</td>
<td>10.018</td>
<td>23.603</td>
<td>29.80%</td>
</tr>
<tr>
<td>Action 11 “Audit”</td>
<td>5.000</td>
<td>5.366</td>
<td>- 366</td>
<td>107.32%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>3.075.413</td>
<td>2.998.819</td>
<td>76.594</td>
<td>97.51%</td>
</tr>
</tbody>
</table>

Comments on the cost categories

Overall the expenditures have been rather in line with what was expected. None of the discrepancies surpassed the allowed flexibility of 30.000 € and 10%. Where discrepancies with the expectations occurred, this can be clarified as follows:

2. Travel and subsistence costs
   Only 14 % of the foreseen budget has been spent. Travel and subsistence costs of SASIL staff which was mostly travelling, had to be declared on form 3, as it concerned the consultants Ercole, Bertuzzi and Van Leijen. Travel costs of for meetings between the partners have never been accounted by any of the two partners, as the distance from Biella to Brusnengo is only 21 km. For longer distances, usually train has been used and low cost flights.

3. External assistance
   90 % of the budget has been spent. The minor spending is caused mainly by the fact that the support of University of Padova amounted to 50,000 € instead of the budgeted 100,000 € and by reduced costs for certification (17.000 € less) with respect to what was expected. The savings were partly spent on erroneously not budgeted travel reimbursements, on the additional services of Giolito & Oglietti Studio Associato for consultancy for assessment of the feasibility, calculations and preliminary design of the structures and coordination of security aspects in design phase; and on higher costs for the definition of lightweight concrete with expanded glass aggregated done by ENCO srl, which resulted more complicated than expected. Further expenses for performance assessment of the demonstration building will be incurred in 2013.

4c. Prototype
   82.6 % of the budget has been spent. 111.550 € has not been spent. The reduction is due to the fact that the demonstration building could not be finalised within the project duration, so major costs item photovoltaic panels had to be acquired after the closure of the project, and will be paid by own resources of Sasil.
6. Consumables
Only 52% of the expected costs was incurred. This was especially due to the reduced energy consumption of the pilot plant with respect to the initial expectations. Moreover, oxygen for redox conditioning didn't need to be acquired despite the original forecast, and chemical and inorganic reagents appeared cheaper than expected.

7. Other costs
Other costs increased with 307%, for a total amount of only 6,871 €. This discrepancy was due to an underestimation of costs for printing and production of dissemination materials, like exposition panels, panel roll-ups and leaflets, used for the many dissemination and sensibilisation activities performed; and for the omission to foresee conference fee of EcoLife.

6.2 Accounting system
Use has been made of the timesheet format supplied by the LIFE programme. The total worked hours have been checked with the time-registration systems present in both partners’ organisations.

Invoices usually mention a reference to the NOVEDI project, which the suppliers are asked to report. In case a supplier forgets this, he is warned for next time and a stamp with the project acronym is placed on the original invoice. Invoices which refer to several expenses only part of which refers to the NOVEDI project are as well stamped with the project acronym and the amount accounted for on the project is reported on it.

6.3 Partnership arrangements
The partnership agreements foresees for arrangements on payment and financial reporting by the partner. On a regular base, the partner was invited to send an updated financial report, completed by himself, accompanied by all the accounting documents. The data were checked by Mrs. Van Leijen, appointed for legal, financial and administrative support. She corrected eventually the financial report; checked calculation of the hourly rate and supplied calculation sheets for this; she asked the partner when necessary to complete or correct documents; and she advised the partner on the regulations regarding contract assignments, publications and book-keeping. At the beginning of the project, intervals were short and the invitation to send documents as example was done almost from project start, as to assure that the partner understood the way of accounting before making errors. Later on intervals got longer.

On occasion of each report, the partner was asked two months before due presentation to update previously sent financial reports and accompanying documentation to allow SASIL to make an updated formal status.

The same practices were applied by the consultant as well to SASIL, in order to advice as early as possible and maintain an updated overview of project expenses, as to avoid any potential overspending or inaccurate accounting practice.

Financial transactions were made by bank transfer. The first under the condition that a financial identification sheet had been presented and the partnership agreement had been signed; the second under the condition that all financial documentation had been properly provided.

6.4 Auditor's report/declaration
The auditor’s report is hereby attached, as the total contribution requested on the project amounts to € 1,158,917.21, which is more than the 300,000 € mentioned as threshold in art. 31.1 of the common Provisions, above which an audit is required. The audit report fully confirms the financial statements attached.
7. Annexes:

7.1 Administrative annexes

Annex 1: partnership agreement (electronic, delivered with inception report)

7.2 Technical annexes

Annex 2: action 1 - Test report “Preliminary studies for the production of glassy foams characterized by low specific weight, high mechanical strength and very strong heat insulation power exploiting the unrecyclable special glasses today destined to the landfill”. (electronic, delivered with inception report)

Annex 3: Deliverable Action 1a: “Report on the ionic desorption in water of selected waste glasses”. (Padua University, Department of Mechanical Engineering, Sector Materials) (electronic, delivered with inception report)

Annex 4: Deliverable Action1b: “Report on the gaseous emissions at 900 and 1100°C from special glasses to be used for producing glass foams with low specific weight and high mechanical strength and heat insulation capability”. (Padua University, Department of Mechanical Engineering, Sector Materials) (electronic, delivered with inception report)


Annex 6: action 3 - Report “Discontinuous preliminary unrecyclable special glasses foaming tests done for screening the conditions to be applied in the laboratory continuous trials”. (electronic, delivered with inception report)


Annex 9: Report ‘Messa a punto di calcestruzzi con aggregati in vetro espanso’ Ing. Silvia Collepardi, Enco Srl. (electronic, delivered with progress report)

7.3 Dissemination annexes

Annex 10: Presentation at LIFE+ 2009 kick off meeting in Rome, 3rd March 2009 (Electronic, delivered with inception report)

Annex 11: Technical presentation NOVEDI (Electronic, delivered with inception report)

Annex 12: Dissemination & Communication Plan 1° edition (Electronic, delivered with inception report)
Annex 13: Press articles on the project (Electronic, delivered with inception report)

Annex 14: Article on the Glass World Wide Magazine (Electronic, delivered with inception report)

Annex 15: Deliverable Action 6: General leaflet on the project (Electronic, delivered with mid-term report)

Annex 16: Programme event 19th of October 2009 (Electronic, delivered with mid-term report)

Annex 17: Programme event 19th of March 2010 (Electronic, delivered with mid-term report)

Annex 18: Invitation letter event 14th of May 2010 (Electronic, delivered with mid-term report)

Annex 19: Programme event 14th of May 2010 (Electronic, delivered with mid-term report)

Annex 20: Questionnaire for public authorities (annex 20) (Electronic, delivered with mid-term report)


Annex 22: Feasibility study, The study is composed of several analyses and a synthesis in Italian and English. Moreover it comprises a Vademecum put at disposal of the target groups (Electronic, delivered with progress report)

Annex 23: Variety of flyers, leaflets, totem, posters and photographs of participation to fairs (Electronic, delivered with progress report)

Annex 24: Deliverable Action 6: Final conference proceedings (Programme and presentations) (Electronic and paper copy)

Annex 25: video registration of final conference 25/05/2012 (CD-Rom)

Annex 26: Audio registration in English of final conference (CD-Rom)

Annex 27: video registration of the interview with the Assessor for Environment of the Province of Biella Mr. Fausto Governato and director of Sasil SpA Mr. Vico Ramon, 06/08/2009 (CD-Rom)


Annex 29: video registration of the local information meetings with citizens 16/06/2011, Biella (CD-Rom)

Annex 30: Layman’s report in Italian (Electronic and paper copy)

Annex 31: Layman’s report in English (Electronic and paper copy)
7.4 Financial annexes:

All financial annexes are delivered in paper and electronic copy.

Annex 32: Financial report, including:

- Signed payment request
- Signed financial statement of the participant – Sasil
- Signed financial statement of the participant – Province of Biella
- Signed project consolidated statement of expenditure and income
- Form 1: Personnel costs
- Form 2: Travel costs
- Form 3: External assistance
- Form 4: Infrastructure
- Form 4.2: Equipment
- Form 4.3: Prototype
- Form 5.1: Land purchase
- Form 5.2 Lease of land
- Form 6: Consumables
- Form 7: Other costs
- Form 8: Overheads

Annex 33: External Auditor’s report

Annex 34: Answers to the financial issues raised by the Commission in his reply to the mid-term report in date 01/09/2010

7.5 Final indicators tables
Annex 35: Final indicators tables