GYPSUM TO GYPSUM

GTOG: From production to recycling: a circular economy for the European gypsum Industry with the demolition and recycling Industry

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After Life Communication Plan

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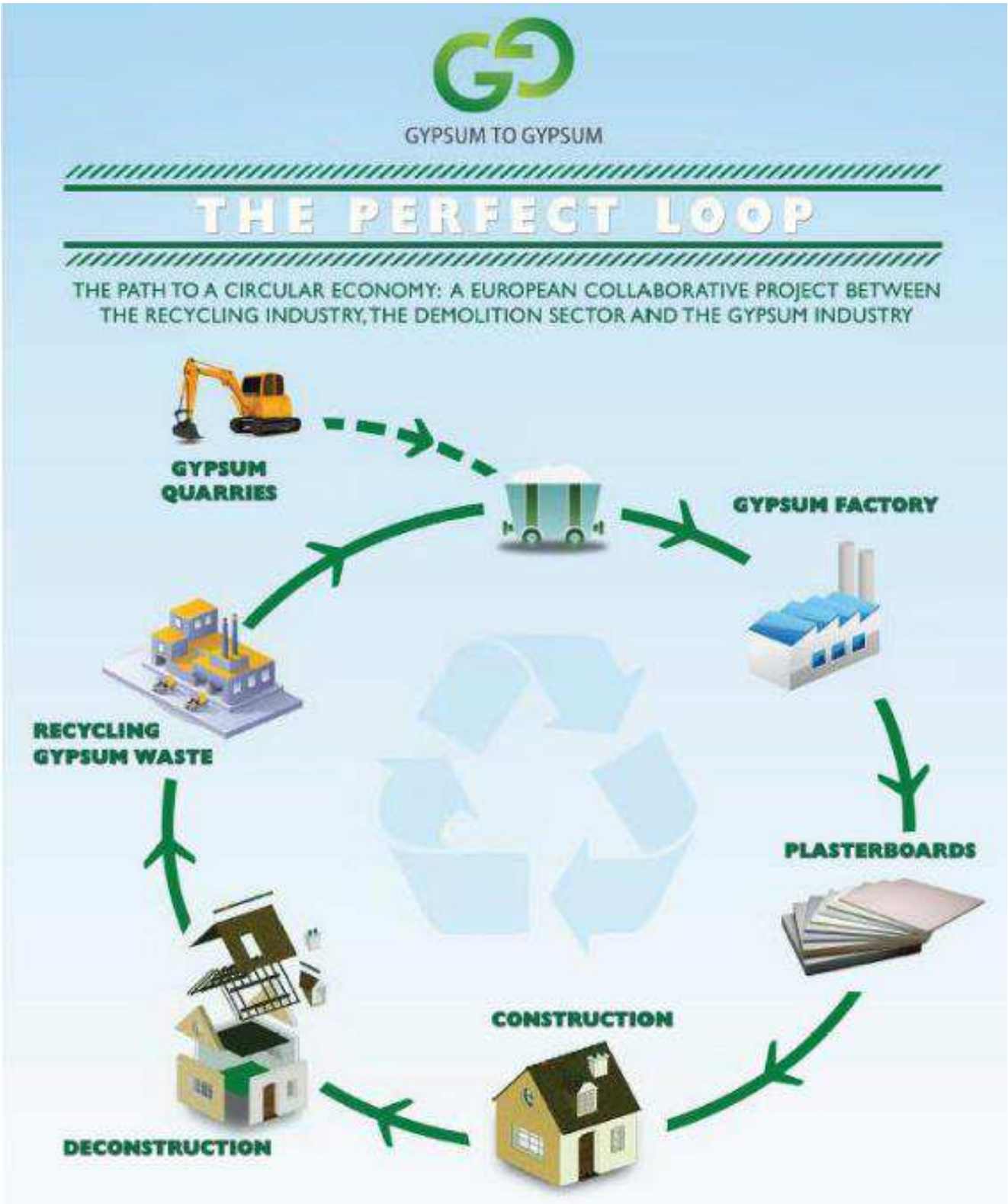
Content


GYPSUM TO GYPSUM
THE PERFECT LOOP
THE PATH TO A CIRCULAR ECONOMY: A EUROPEAN COLLABORATIVE PROJECT BETWEEN THE RECYCLING INDUSTRY, THE DEMOLITION SECTOR AND THE GYPSUM INDUSTRY
GYPSUM QUARRIES
GYPSUM FACTORY
PLASTERBOARDS
CONSTRUCTION
DECONSTRUCTION
RECYCLING GYPSUM WASTE

GYPSUM TO GYPSUM

I. Background

➢ Gypsum – an exceptional construction material

Gypsum is a rock-like mineral used in construction through different applications, mainly plasterboards, building plaster and gypsum blocks.

The GtoG project focuses on lightweight gypsum components, also known as plasterboards, which mainly consist of gypsum cores covered with paper in their surfaces and longitudinal edges. These products are used for partitions, lining walls and ceilings. Other generic terms used for these products are gypsum boards, drywalls and wallboards.

Their main properties are:

- Easy to handle and install
- Recyclable
- Very good fire performance
- High levels of robustness against impact
- Easily combined with insulation materials providing good thermal and acoustic properties to the system

➢ The context

The construction sector represents an important constituent of the European economy. However, this sector generates one of the heaviest and most voluminous waste streams in the European Union, the so-called Construction and Demolition (C&D) waste. This waste arises from activities such as the construction of buildings and civil infrastructure, or their total or partial demolition including renovation activities and maintenance. It accounts for approximately 30% of all waste generated in the EU[1] and consists of numerous materials, including concrete, bricks, wood, glass, metals, plastic, solvents, asbestos as well as excavated soil and of course gypsum, many of which can be recycled.

Despite the fact that gypsum is 100% recyclable, there is currently a large proportion of gypsum waste being landfilled and backfilled, while recycling systems in Europe are mostly operating in Benelux, Denmark, Finland, France, Norway, Sweden and the United Kingdom.

As a C&D waste fraction, gypsum based wastes can be differentiated into three categories depending on their origin:

- Production waste, meaning the waste resulting from the manufacturing process.
- Construction waste, the waste resulting from new buildings construction sites.

[1] BioIS: Management of construction and demolition waste in the EU - requirements resulting from the Waste Framework Directive and assessment of the situation in the medium term (draft final report, 2010). Note: for some Member States, only data for 2004 were available

- Demolition waste, the waste arising when refurbishing or removing existing buildings, thus including both demolition and renovation waste.

The GtoG project focused on eight EU target countries (Belgium, France, Germany, Greece, Poland, Spain, the Netherlands and the UK); estimating that around 1,150,000 tons of plasterboard waste was generated in 2012. In most of these European countries, a low recycling rate of gypsum waste was observed.

The aim of the GtoG project was to produce plasterboard with up to 30% content of recycled gypsum coming from both production and C&D waste.

Main types of gypsum

Gypsum is an abundant mineral rock from which plaster is made and is commonly found in quarries. The European gypsum industry comprises 160 quarries and about 200 factories (plaster powder plants, plaster block plants and plasterboard plants), which directly employs 28,000 people and creates products for more than 850,000 users.

Until mid1980s most of the gypsum used in the European Union was natural gypsum extracted from quarries. Since then, flue gas desulfurization (FGD) gypsum, a by-product from coal-fired power plants, has become an alternate and important supply for the gypsum industry. This raw material is also known as synthetic gypsum and largely used in Belgium, Germany, the Netherlands and Nordic countries.

The origin of the main types of gypsum is summarized in Table 1.

Resource	Origin
Natural gypsum	Formed geologically
FGD gypsum	By-product from desulphurization of gases in coal-fired power stations
Recycled gypsum	From processing of gypsum waste in accordance with particular specifications

Table 1, origin of the main types of gypsum

Reasons for recycling plasterboard products

1. **Gypsum is fully and eternally recyclable**. Gypsum products can be recycled because their chemical composition remains unchanged. Gypsum`s chemical composition is calcium sulphate dehydrate which exist in nature in a rock-like shape. When heated (calcined), calcium sulphate hemihydrate is created, a substance that can be formed into shape and hardened by adding water (new gypsum products are made), whereby the material is turned into the original and naturally occurring gypsum state again. Therefore, gypsum products can be counted amongst the very few construction materials where “closed-loop” recycling is possible, i.e. where the waste is used to make the same product again.

2. Article 4 of the Directive 2008/98/EC on Waste (also known as the Waste Framework Directive, hereinafter WFD) drafts the **waste hierarchy** that should be applied as a priority in all EU Member States. Waste prevention leads this hierarchy, followed by preparing for re-use and material recycling that should always be preferred to recovery and landfill disposal.

3. Article 11 of the WFD establishes that, by 2020**, the preparing for re-use, recycling and other material recovery of most of the categories defined in the European List of Waste (ELW) shall be increased to a minimum of 70% in terms of weight**. This target applies to non-hazardous C&D waste (where gypsum waste is included) and excluding soil and stones other that those containing dangerous substances.

4. If gypsum waste products are accepted at normal cells in non-hazardous landfills with biodegradable waste, its sulphate would break down, amongst other substances into **hydrogen sulphide (H_2S), a hazardous flammable gas with environmental and health effects when inhaled**, that even in very small concentrations creates odour problems and is dangerous. Council Decision 2003/33/EC, therefore, established that "*Non-hazardous gypsum-based material should be disposed of only in landfills for non-hazardous waste in cells where no biodegradable waste is accepted. The limit values for TOC and DOC given in section 2.3.1 and 2.3.2 shall apply to wastes landfilled together with gypsum based materials*". When the gypsum waste is separated from organic matter, the risk of formation of Hydrogen Sulphide is limited.

5. Recycling plasterboard waste avoids **primary mineral resource depletion**.

➢ GtoG, closing the loop effectively

Closed loop recycling involves a close collaboration among all the stakeholders throughout the entire value chain: from the dismantling and collection of plasterboard waste in buildings, via the recycling of this waste and culminating with the reincorporation of the recycled gypsum by the plasterboard manufacturing plants, in order to create a highly efficient reverse logistics.

The GtoG project will serve to boost the closed-loop recycling route whenever possible.

➢ Deconstruction: dismantling of plasterboard on the demolition site

Deconstruction enables the quantity and quality optimization of valuable materials, thereby increasing the potential for their future recycling. It results in different waste fractions with minimal damage, due to the time and care taken for separating the waste, in order to achieve the minimal negative effect of its generation.

➢ The reprocessing of the recyclable plasterboard waste

Once plasterboard waste from construction and demolition waste is separated on site, it can be collected by a third party and transported to a gypsum recycler for processing.

- **The reincorporation of the recycled gypsum in the manufacturing process**

  Once the plasterboard waste has been processed, the gypsum recycler provides the manufacturer with the recycled gypsum that will be reincorporated in the production process.

II. The GtoG project structure

The GtoG project has put in place an integrated approach to C&D waste by holistic management, starting from the major refurbishment/demolition sites to the reincorporation of the recycled gypsum in the manufacturing process via the processing of gypsum waste as a secondary raw material.

The project structure has been conceived to be simple and comprehensive at the same time. Indeed, the project has developed all its technical activities through three actions:

- **Action A** analysed and evaluated the **current practices** in deconstruction/demolition, C&D waste characterization, processing the gypsum waste for the production of recycled gypsum and its reincorporation into the manufacturing process. This action represented a sort of introduction to GtoG, where a technical, economic, environmental and legislative analysis was carried out for the different stages of the value chain. This analysis has been performed by UPM (Universidad Politécnica de Madrid, Spain) with the collaboration of all the partners, who provided astute information about deconstruction, recycling and re-incorporation of recycled gypsum into the production process. The result has been an **Inventory of best practices.**

- **Action B**, the project implementation actions, where **five pilot projects** implementing the deconstruction techniques, the decontamination and the waste qualification, reprocessing and reincorporation in gypsum manufacturing plants have been carried out in **Belgium, France** (2)**, Germany and UK**. This action has been developed through the following sub-actions:

  - **The 5 deconstruction projects.** Recovering, a French consulting company, led this action. This activity has been implemented by the five demolishers in the project (Recass for Belgium, KSE for Germany, Occamat and Pinault & Gapaix for France and Cantillon for the United Kingdom), who selected commercial buildings, where gypsum products and systems have been audited and deconstructed, using various techniques and practices.

  - **The 5 recycling projects.** Gypsum Recycling International A/S (GRI) led this action, and counted on the participation of the other recycler for the project, New West Gypsum Recycling (NWGR). In this sub-action, the plasterboard wastes supplied by the deconstruction project have been processed and then transferred as recycled gypsum powder to the five manufacturer's plants to be re-incorporated in the production process.

- **The 5 reincorporation projects.** The National Technical University of Athens (NTUA) led this action, and coordinated the five gypsum manufactures of the project (Saint Gobain Gyproc for Belgium, Placoplâtre and Siniat SA for France, Knauf Gips KG for Germany, and Siniat Ltd for the United Kingdom). Within the sub-action, the recycled powder supplied by the recyclers has been re-incorporated into the production process. The recycled gypsum powder used during the re-incorporation phase has also been tested by the laboratory LOEMCO (Fundación Gomez Pardo, Spain).

- **Action C**, which monitored the impact of the project actions. The end result has been a **report on best practice indicators,** the responsibility of the UPM (Universidad Politécnica de Madrid, Spain). In addition, other outcomes of this action have been the **carbon footprint of gypsum: landfilling versus landfilling route**, developed by UPM, and **the roadmap for implementing a gypsum sustainable value chain**, a document created by Eurogypsum, where an outline plan has been determined in order to achieve a more widespread implementation of gypsum C&D waste recycling.

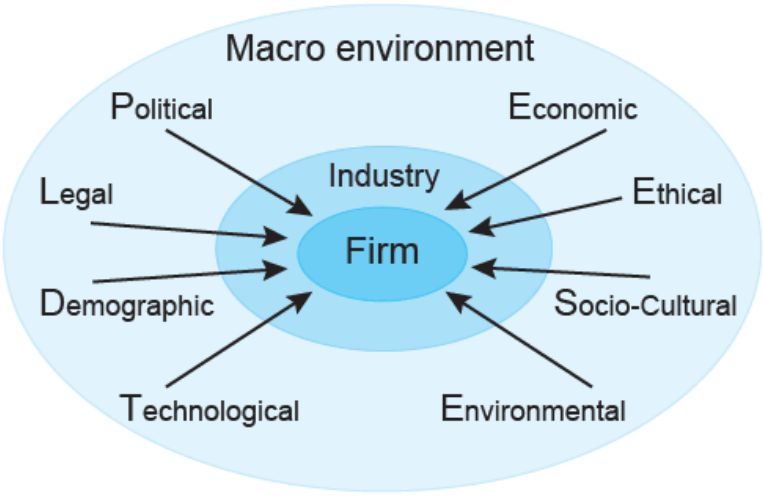
III. Project results

- Preliminary study (UPM, January – September 2013)
  - **The inventory of current practices for deconstruction, recycling and re-incorporation in the manufacturing process of the recycled gypsum**
- Dismantling VS demolition (Recovering, September 2013 – March 2014)
  - **The European handbook of best practices for controlled deconstruction of gypsum system** and **the European manual of best practices for the audit of building prior to deconstruction**
- Recycling (GRI and NWGR, February 2014 – September 2015)
  - **European guidelines on gypsum waste acceptance criteria**
  - **Quality criteria for recycled gypsum, technical and toxicological parameters**
- Re-incorporation (NTUA, February 2014 – September 2015)
  - **Techno-economic assessment of recycled gypsum incorporation into the plasterboard manufacturing process**
- Final Study (UPM and Eurogypsum, October 2013 – December 2015)
  - **Report on best practices indicators for deconstruction, recycling and re-incorporation practices**
  - **Roadmap for future implementation of a sustainable value chain**
  - **Inventory of best practices for deconstruction, recycling and re-incorporation**

IV. After Life Communication plan

➢ Setting up national value chains for the recycling of gypsum based waste

Across Europe, the plasterboard market maturity differs, as the plaster consumption and recyclability rates change very much. Moreover, the market is only one factor that influences the plasterboards recycling rate. In fact, the recycling of plasterboards production, construction and demolition waste depends greatly on a macro-environment formed by different elements that vary considerably country by country.



The questions that each operator should ask themselves and in partnership are the following:

- What is the political situation of the country and what impact does this have on the gypsum waste value chain development?
- What are the EU legislations affecting gypsum waste management?
- Is the national policy favouring dismantling? How to create a dismantling culture? How to promote standardisation for dismantling? How to define dismantling?
- What are the prevalent economic factors to recycle more?
- How much importance does culture have in the gypsum recycling market and what are its determinants?
- What technological innovations are likely to pop-up and affect the gypsum recycling market structure?
- Which technological progress is necessary in the gypsum waste value chain to make recycling an effective business?
- What are the environmental concerns for the gypsum value chain to recycle more?

The main aim is to achieve constant volume, constant quality of the recycled gypsum and an economic gain for each operator in the value chain.

In any case, a fit-for-all solution might not be most adequate. Therefore, we suggest that the proper set-up, establishment, development and support of the plasterboard value chains

should be done at country level, with a constant and significant exchange of best practices all around Europe. As a minimum the national authorities of each member state should start by assuring that the national legislation is in full compliance with EU waste laws, such that all EU waste laws with consequences for plasterboard recycling have been properly implemented and enforced.

➢ The recommendations for the European Commission

The C&D waste recovery target of 70% (Waste Framework Directive)

In accordance to the recently published communication on resource efficiency opportunities (COM (2014) 445 final), we support the Commission proposal to promote the exchange of best practices with Member States on measures that divert CDW from landfilling and backfilling, either through increased charges or regulatory measures.

In this regard, the Waste Framework Directive (WFD) could be an important tool for driving the recycling of CDW. However, the EU authorities set a target for recovery operations including recycling operations. Therefore, the current 70% recovery target (by 2020, including backfilling operations) for non-hazardous waste become an ambiguous tool and deserves a strong reorientation by the European authorities.

Backfilling should be defined carefully as it is not per se a recovery operation but can also be a legal conversion into a landfill site at the place of a former quarry. Any target should be postponed until we rely on robust statistic and calculation method.

Improve the statistics for C&D waste

There is a need for detailed and reliable statistics on materials available from construction and demolition activity. The volume of plasterboard waste stemming from renovation activities is unknown, but could offer potential. Current day statistics on plasterboard waste generation are non-existent or too approximate due to the lack of data. Moreover, the statistics at European level are not harmonized which slows down the incentives to recycle effectively. With the lack of good information and incentives, a recommendation is required to include the breakdown of the different streams in the Eurostat database, differentiating at least among: plastics, metals, concrete and rubble, roofing and plasterboard. This could be easily achieved for countries in this project, where deconstruction is a common practice, such as Belgium, France, the Netherlands and the UK.

Design for disassembly

The design for disassembly is one of the points to be assessed, as architects and contractors do not have today the mentality of “recyclability”. Architects focus on energy efficiency although an important aspect for buildings but not the sole one.

Indeed, the full activities and impact of the design for disassembly is presented below:

1. Minimise the number of different types of components – this will simplify the process of sorting on site and make the potential for reprocessing more attractivly due to the larger quantities of equal or similar items.

2. Use an open building system where parts of the building are more freely interchangeable and less unique to one application – this will allow alterations in the building layout through relocation of component without significant modification.
3. Use modular design and components that are compatible with other systems and/or with standard building practices, both dimensionally and functionally – specialist technologies will make disassembly difficult to perform and may require specialist labour and equipment that makes the option of reuse more difficult.
4. Provide access to all parts of the building and all components – ease of access will allow ease of disassembly, if possible allow for components to be recovered from within the building without the use of specialist plant equipment.
5. Use components that are sized to suit the intended means of handling – allow for various possible handling options at all stages of assembly, disassembly, transport, reprocessing, and re-assembly.
6. Provide a means of handling components during disassembly – handling during disassembly may require points of connection for lifting equipment or temporary supporting devices.
7. Provide realistic tolerances to allow for movement during disassembly – the disassembly process may require greater tolerances than the manufacture process or the initial assembly process.
8. Design joints and connectors to withstand repeated use – to minimise damage and deformation of components and materials during repeated assembly and disassembly procedures.
9. Allow for parallel disassembly rather than sequential disassembly – so that components or materials can be removed without disrupting other components or materials, where this is not possible make the most reusable or 'valuable' parts of the building most accessible, to allow for maximum recovery of those components and materials that are most likely to be reused.
10. Use prefabricated subassemblies and a system of mass production – to reduce site work and allow greater control over component quality and conformity.
11. Provide spare parts and on-site storage for them – particularly for custom designed parts, both to replace broken or damaged components and to facilitate minor alterations to the building design.
12. Sustain all information on the building manufacture and assembly process – measures should be taken to ensure the preservation of information such as 'as built drawing', information about disassembly process, material and component life expectancy, and maintenance requirements.

Mandatory audit of building prior to demolition

Deconstruction (dismantling and sorting/separating on site) is essential for recycling and should become the focus of European regulatory and non-regulatory measures in the future. Similarly sorting on new construction sites is essential for preparing waste for recycling. In that sense, an audit of all materials in the buildings prior to construction and deconstruction is a step towards a dismantling culture, at least for building above 1000 square meters. A detailed

report, in some countries referred to as a Building Waste Management Plan, about the quantity, quality and recyclability of the waste materials should be the result of the audit. Such Building Waste Management Plan could be considered to be made mandatory for receiving a permit for a given construction/demolition activity.

Financial support for technology deployment and development

The funding of collaborative value chain to recycle specific waste streams via the financial tools of the European Commission is essential for the uptake of a recycling mentality of C&D waste.

In the case of gypsum products, the recycling technologies should be further enhanced in a collaborative manner to recycle the today non-recyclable plasterboard systems and to improve the current quality requirements (technical and chemical) of the recycled gypsum via a voluntary quality certification of the recycling process. This would facilitate the uptake of a product status for the recycled gypsum at national level or if the conditions are there, at European level. In that case, we support the Commission proposal in the communication on resource efficiency opportunities in the building sector[2] to explore options for measures to ensure that recycled materials meet necessary quality and safety requirements, through standardization and certification.

➢ The European gypsum industry forthcoming steps

Design for recycling

The environmental preference is ultimately to reduce waste at source, namely at the design stage. The gypsum industry has put in place policies to prevent waste, for example by internal recycling of production waste and, thus, saving resources and following the waste hierarchy of the Waste Framework Directive.

In any case, this is a point on the agenda of the gypsum manufacturers that will be developed even more via their R&D centres. Such developments could increase the materials recyclability and promote a mentality of waste prevention.

Selective demolition of plasterboard systems

- Enhancement of the reference catalogue on gypsum-based systems built 20-30 years ago. Within the project framework, this catalogue covers Belgium, France, Germany, and the UK. It should be extended in 2016 with the Netherlands, the Scandinavian countries and Austria.
- Dissemination of the best practices to dismantle plasterboard systems via the European and national demolition and gypsum associations.
- Enhance the cooperation with the European Demolition Association to increase the uptake of plasterboard dismantling bearing in mind that high volumes coming from this source are not currently available.

[2] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52014DC0445

Recycling (processing of the plasterboard waste) and re-incorporation in the manufacturing process

Set up a collaborative platform between the gypsum recyclers (independent or producers assuming the role and activities of the recyclers) spread in Europe (mainly the UK-France-Belgium-Germany-The Netherlands-Ireland) to exchange best practices and to decide on common actions regarding:

- The technical and chemical parameters for the recycled gypsum and their evolution.
- Recyclable plasterboard waste definition and waste acceptance criteria for countries not covered by the project.
- Certification of the recycling process.
- Development of innovation to recycle currently non-recyclable plasterboard systems and other gypsum waste.
- The definition of the product status of the recycled gypsum. How to progress on this issue.
- Monitoring of the waste legislation at EU and national level-bi-annual newsletter.
    - To monitor the waste legislation at EU and national level, including their correct implementation, with the creation of dissemination tools such as a bi-annual newsletter.
    - To reach a point in which the optimization of the recycling and reincorporation processes materialized during the GtoG project would become “business as usual”.
    - To implement a full collaboration for assuring that an economic viable recycling system is set up.
    - To investigate in each member state whether the definition of the product status for the recycled gypsum at national and/or plant level would be useful or not.
    - To prepare applications to current EU funding instruments for implementing new collaborative pilot projects able to boost R&D&I activities and show the benefits of an uptake of C&D waste recycling.

GYPSUM TO GYPSUM

V. 17 partners for covering an integrated supply chain

The GtoG is a LIFE project co-financed by the European Commission. It covered the duration of three years, from January 2013 to December 2015.

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A working team of 17 Partners

Coordinator

- Eurogypsum, the European association of plasterboard manufacturers, Belgium

Universities

- The National Technical University of Athens, Greece
- Universidad Politécnica de Madrid, Spain

Laboratory

- Fundación Gomez Pardo (LOEMCO), Spain

Consulting agency

- Recovering SARL, France

Demolition companies

- Occamat, France
- Cantillon Ltd, UK
- Recycling assistance BVBA, Belgium
- Pinault & Gapaix, France
- KS Engineering, Germany

Recycling companies

- New West Gypsum Recycling Benelux BVBA, Belgium
- Gips Recycling Dan mark A/S, Denmark

Gypsum manufacturing companies

- Placoplâtre SA (Saint Gobain group), France
- Siniat SA, France
- Siniat Ltd, United Kingdom
- Knauf Gips KG, Germany
- NV Saint Gobain Construction Products Belgium SA (Gyproc), Belgium

VI. LIFE Programme

The LIFE programme is the EU's funding instrument for the environment and climate action. The general objective of LIFE is to contribute to the implementation, updating and development of EU environmental and climate policy and legislation by co-financing projects with European added value.

LIFE began in 1992 and to date there have been four complete phases of the programme (LIFE I: 1992-1995, LIFE II: 1996-1999, LIFE III: 2000-2006 and LIFE+: 2007-2013). During this period, LIFE has co-financed some 4 171 projects, contributing approximately €3.4 billion euros to the protection of the environment and climate.