

Gypsum to Gypsum (GtoG): The European Life+ Project That Aims to Transform the Gypsum Waste Market

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Abstract

The GtoG project is working for creating a recycling culture of gypsum products, changing the way this waste is usually treated in construction, renovation and demolition works, with the aim of achieving higher gypsum recycling rates in Europe and promoting selective deconstruction practices. For this purpose and under the leadership of Eurogypsum (the European Plaster and Plasterboard Manufacturers Association) five demolition companies, one demolition consultant, two gypsum waste processors, five plasterboard manufacturers and three academic partners, from 7 European countries, work together constituting the project consortium.

A preliminary study on current practices was completed in 2013. Subsequently in 2014, a set of demonstration activities on deconstruction, processing of gypsum waste and reincorporation of recycled gypsum were conducted. Finally, during this year 2015, different results have been delivered, such as the “European Handbook of best practices for controlled deconstruction of gypsum systems” and the “Report on best practice indicators for deconstruction, recycling and reincorporation practices”. The final results will include an Inventory of best practices and the Roadmap for the future implementation of a sustainable value chain.

Keywords: GtoG project, gypsum recycling, selective deconstruction, plasterboard.

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Introduction

The European Gypsum Industry is one of the fully integrated industries within the construction sector, covering the whole life cycle of the gypsum products from cradle to cradle as gypsum products are indefinitely and fully recyclable. For this reason, gypsum companies strive to effectively recycle the products at the end of their life cycle. Nevertheless, a large proportion of gypsum waste is still landfilled and backfilled worldwide (European Commission, 2011), including building plaster, gypsum blocks and plasterboard, being the latter the most common recyclable gypsum waste generated.

Gypsum waste can be differentiated in three categories based on its origin:

- Production waste (e.g. plasterboards which do not meet specifications and waste resulting from the manufacturing process).
- Waste generated in new construction sites.
- Demolition waste. It includes both demolition and renovation waste and it is the most complex to address because it is usually mixed C&D waste.

Focusing on demolition waste, practices implemented nowadays represent the main barrier to create a recycling culture within the construction industry, leading to mixed C&D waste which is disposed of in landfills reducing the possibilities to recover valuable recyclable materials, and contributing to an increase in the environmental impacts. Therefore, when this product with such composition is disposed of in a landfill site in contact with organic matter, presence of water and absence of air, decay is induced as well as the generation of hydrogen sulfide gas, which is a toxic substance (Barbudo, Galvín, Agrela, Ayuso, & Jiménez, 2012; López & Lobo, 2012). Methane (CH₄) and carbon dioxide (CO₂) emissions are also generated, caused by the degradation of the paper content (WRAP and Environmental Resources Management Ltd (ERM), 2008).

Wherefore, in 2002 as part of the process of establishing criteria and procedures for the acceptance of waste at landfills, the EU reclassified gypsum products as high sulphate, non-hazardous non-inert waste (European Commission, 2010).

The Waste Framework Directive (WFD) is an important tool for driving C&D waste recycling. The EU has set an ambitious target in the WFD of 70% for the recycling of Construction and Demolition (C&D) waste. In this respect, although gypsum is only one of a number of C&D wastes, the European Gypsum Industry is determined to play its part in helping the EU to achieve this target. Moreover the Directive prioritizes recycling upon landfilling (European Parliament and Council, 2008). In addition, the Council Decision 2003/33/EC, establishes criteria and procedures for the acceptance of waste at landfills. Section 2.2.3 specifically addresses gypsum waste, and requires non-hazardous gypsum-based materials to be disposed of only in landfills for non-hazardous waste in cells where no biodegradable waste is accepted" (The Council of the European Union, 2003).

Lastly, in 2010, the European Gypsum Industry developed with the European Commission the Green Public Procurement (GPP) Criteria for Wall Panels, including Gypsum Plasterboard Wall Panels (European commission, 2008). GPP Criteria establishes that for the purchase of environmentally sound wall panels the gypsum

content must be at least 5% recycled gypsum board and when higher percentages are possible they should be selected in preference.

The GtoG project

The GtoG project *“From Production to Recycling: A Circular Economy for the European Gypsum Industry with the Demolition and Recycling Industry”*, is co-financed by the Life+ Programme of the European Commission. It started in January 2013 and will finish in December 2015. The participating consortium is coordinated by Eurogypsum, European federation of national associations of gypsum products manufacturers, and consists of 17 partners (2 universities- 5 demolition companies-1 consultant in deconstruction- 5 gypsum manufacturers-1 laboratory- 2 recyclers) from seven European countries (Figure 1).



Figure 1. Representatives of the GtoG project consortium during the kick-off meeting.

The overall aim of the GtoG project is to transform the gypsum demolition waste market to achieve higher recycling rates of gypsum waste, thereby helping to achieve a resource efficient economy. The market transformation will start happening with the establishment of the project as a collaborative business model between the demolition industries, processing and manufacturing industries.

Such closed-loop recycling for gypsum products will only happen if:

- Deconstruction techniques are applied for all demolition or refurbishment projects;
- Sorting of waste is done at source - thereby avoiding mixed waste;
- Processing is carried out according to clear standards;
- Incorporation in the production process is carried out with innovative processes.

Thereupon, the GtoG project seeks to put in place an integrated approach in order to holistically manage construction and demolition waste, from gypsum products deconstruction to recycled gypsum reincorporation, via gypsum waste processing as a secondary raw material. The integrated approach proposed in the project, pleads for a multinational partnership involving all major stakeholders in the value chain (demolition companies, processing and manufacturing industries). This integrated approach could be extended, adapted and applied to any other type of construction material used in construction (Figure 2).



Figure 2: Plasterboard value chain integrated approach.

As specific objectives, the following must be highlighted:

- Diagnosis of the building. To achieve the overall objectives, it is necessary to focus first on the deconstruction practices and to demonstrate the feasibility and advantages of deconstruction versus demolition.
- Processing gypsum demolition waste. The major objectives of processing are separation of the gypsum from the paper and the size reduction of gypsum waste.
- Qualifying gypsum waste. The above-mentioned separation is done according to agreed specifications between the gypsum processors and the gypsum manufacturers in a contractual form.
- Incorporation of the processed gypsum into the manufacturing process, including an assessment of technical difficulties, options and solutions. By developing innovative techniques in manufacturing plants, GtoG aims to incorporate up to 30% of secondary gypsum in plasterboards.
- Production of European criteria for recycled gypsum to establish the end-of-waste (EoW) status and apply for a Council regulation to confirm these criteria under Directive 2008/98/EC.
- On the basis of the results of point 1 to 4, establish, if feasible, a recycling target for gypsum waste.
- Reassessment of the 5% of recycled gypsum in the Green Public Procurement Criteria for Wall Panels (i.e. plasterboard) developed by the European Commission.
- Assessment of the carbon footprint and the methods to mitigate it at the construction level, transport level, processing level and manufacturing level.

In order to achieve the aforesaid, it is necessary to analyse how the value chain operates in different countries. For this reason, the project targets and involves partners from the major EU gypsum product dismantlers, processors and producers.

Methodology

The European Gypsum Industry has global players but produces locally with high technical and environmental standards and with great respect for the local communities. The business and technical response of the large players responds to the culture, needs and legislative/technical requirements of the local economy. In that aspect, production processes are similar, but not the same. Initiative for greening the products are taken at plant level and differ from one plant to the other, from one country to the other, resulting in competition inside the same company.

On the other hand, the majority of demolition companies are SMEs focused on the local market, also with different approaches and initiatives.

Regarding the gypsum processing market, it mainly consists of two companies that act locally in each country with the process developed by the two companies. In the UK, some gypsum recycling companies are starting to develop for the UK market,

although recycling demolition gypsum waste is still concentrated because the market is still small.

In view of the above-mentioned, and following the structure of the Life Programme, the project develops its technical activities through three actions (Figure 3):

- Action A, which analyses and evaluates the current practices in deconstruction/demolition, C&D waste characterization, processing of 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 is carried out for deconstruction, recycling and manufacturing of plasterboard.
- Action B, the project implementation action, where 5 pilot projects implementing the deconstruction techniques, the processing and reincorporation in gypsum manufacturing plants is being carried out in Belgium, France, Germany and UK.
- Action C, where the outcomes of the pilot projects are being used to reassess the findings of the surveys carried out in action A. The end result will be a report on best practices to recycle plasterboard waste throughout the entire value chain.

PREPARATORY ACTIONS: ECONOMIC AND TECHNICAL SURVEYS

In order to reach the main goal of the GtoG project, due to the strong regional orientation, current practices in deconstruction – demolition, C&D waste characterization, gypsum recycling and the reincorporation of the recycled gypsum into the plasterboard manufacturing process were firstly explored in the preparatory actions of the project. An analysis of practices and economics of the plasterboard value chain was conducted in 2013 in the major European member states gypsum product consumers. This academic survey –preparatory phase- covering Belgium, France, Germany, Greece, Poland, Spain, the Netherlands, and the United Kingdom, was mainly carried out by the two participating universities and the deconstruction consultant company.

Action A.1 Value chain analysis in terms of deconstruction methodologies, economics of logistics and recycling

This action is the core preparatory action of the project and aims to establish the technical and economic characteristics of the deconstruction chain of gypsum lightweight systems leading to recycling versus landfilling. It builds an inventory of current practices in deconstruction, processing and industrial use of recycled material.

Action A1 is divided in the following Sub-Actions:

- A1.1 Deconstruction practices - Economics of deconstruction & logistics
- A1.2 Recycling and plasterboard manufacturing practices
- A1.3 Technical-Economic-Legislative-Environmental criteria

IMPLEMENTATION ACTIONS: PILOT PROJECTS

A second phase is focused on demonstration activities on deconstruction, gypsum recycling and reincorporation of recycled gypsum, activities being part of the End-of-Life (EoL) stage of the gypsum plasterboard. The demonstration activities of the GtoG project have been carried out in, Belgium, Germany, France and The United Kingdom. The outcomes of these pilot projects are used to reassess the findings of the surveys carried out in 2013 and produce the Best practice report on gypsum recycling.

Action B.1 Eco-efficiency of deconstruction/segregation: Technical/economic/ market feasibility

This Action is the first implementation action of the project, dealing with optimization

of current practices in the deconstruction/segregation of lightweight gypsum from C&D waste identified in Action A1. It involves the systematic recording of deconstruction procedures in the various EU countries, based on building typology and linking them to the existing legislation.

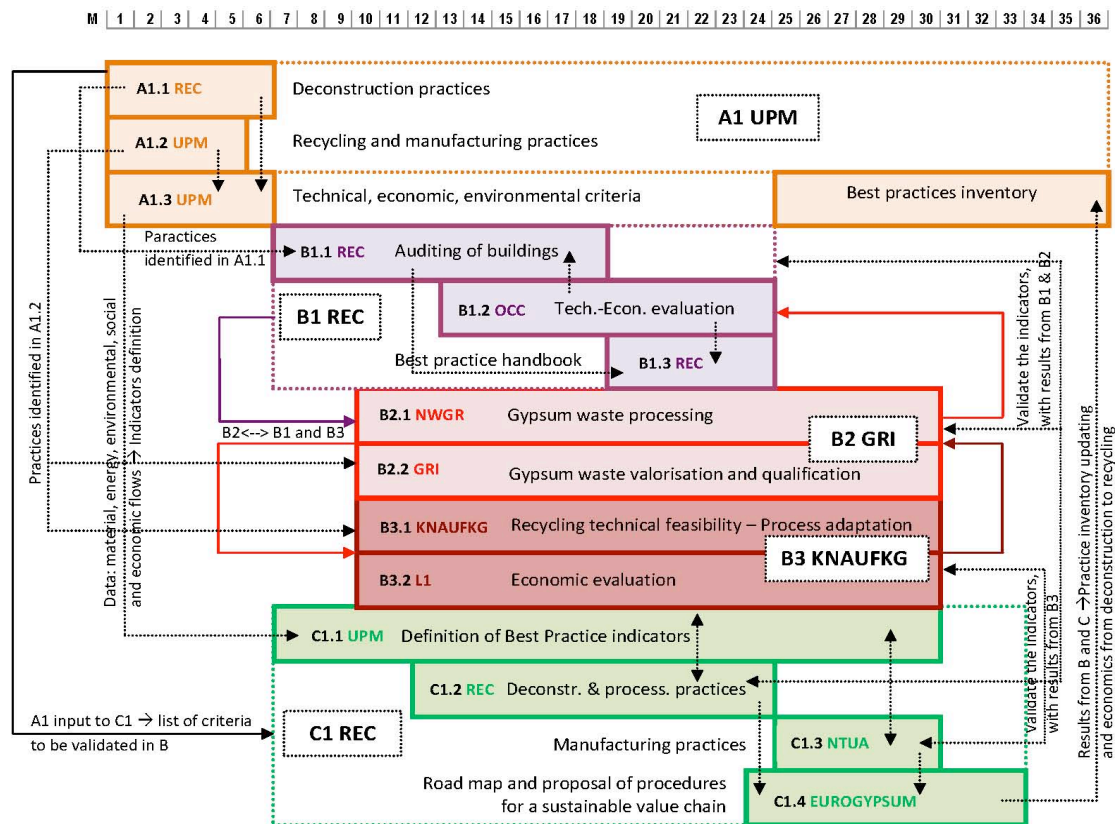


Figure 3. Structure of the GtoG project actions.

Action B1 aims to identify and elaborate the most appropriate procedures and practices for deconstruction of lightweight systems and to implement these on selected pilot projects. The action is divided in the following sub-actions:

- B1.1 Auditing of buildings – deconstruction projects
- B1.2 Technical-economic evaluation of deconstruction steps
- B1.3 Preparation of “best practice” handbooks

Action B.2 Valorisation of deconstruction waste

The second phase of the implementation activities has addressed the issues of optimization of methods and practices in order to obtain processed gypsum with properties that are 90% similar to natural gypsum. This, in turn, will enable easier incorporation of the gypsum into the manufacturing process and the establishment of the EoW status for recycled gypsum. After gypsum materials have been segregated from other products it is necessary to ensure that the secondary gypsum that will be obtained from the waste processing is suitable for ultimate reprocessing. For this reason, gypsum waste must be accurately qualified, and decontaminated.

In Action B2, the gypsum waste received from the four different deconstruction sites is qualified and re-assessed to ensure that the waste is suitable for reprocessing. The properties of the secondary gypsum are agreed between the waste processors and the manufacturers. The foreseen sub-actions within this Action B2 are:

- B2.1 Processing of deconstruction gypsum waste
- B2.2 Valorisation and qualification of deconstruction gypsum waste

Action B.3 Towards sustainable lightweight systems

After having defined the best practices for each step of the value chain in Actions B1 and B2, Action B3 integrates the achieved results to demonstrate, at industrial level, the optimized value chain and to support widespread dissemination routes through the following Sub-Actions:

- B3.1 Gypsum waste recycling. Technical feasibility-Process adaptation
- B3.2: Economic evaluation. Energy and raw material saving potentials

MONITORING OF THE DECONSTRUCTION, PROCESSING AND MANUFACTURING PROCESSES.

At the same time, the impact from the project actions is gathered through a set of monitoring indicators that have been defined in the project.

Action C.1 Monitoring of impact in the value chain (cradle to cradle approach)

This Action constitutes the best waste management options for gypsum demolition waste (reuse and recycling versus landfilling). The results of the systematic and methodological improvements in all stages of the value chain (from Actions B1 to B3), are assessed by the best practice indicators. The validity of the best practice indicators is also verified by the monitoring activities where corrective actions are proposed if needed.

The following sub-actions have already been developed:

- C1.1 Definition of Best Practice indicators
- C1.2 Monitoring of deconstruction and processing practices
- C1.3 Monitoring of manufacturing practices

Results

The main result achieved during the first phase of the Preparatory Actions, has been an inventory of current practices for deconstruction, recycling and reincorporation in the manufacturing process of the recycled gypsum. This document establishes the technical and economic characteristics of the deconstruction chain of gypsum lightweight systems leading to recycling versus landfilling. It builds an inventory of current practices in deconstruction (diagnostic of the buildings, audit of the material to be deconstructed, deconstruction, decontamination, and segregation), processing and industrial use of the recycled material.

Furthermore, a framework for assessing the success of gypsum recycling, consisting on six indicators influencing closed-loop gypsum recycling, has been formulated. On the other hand, in relation to the Monitoring Actions, a set of technical-economic-environmental and social criteria in the form of monitoring indicators have been defined and used for gathering information from the pilot projects. Based on the analysis of the monitoring indicators, a report of Best Practice Indicators for deconstruction, recycling and reincorporation practices have been drafted. Within the second phase of the Preparatory Actions, an Inventory of best practices will be ready at the end of the GtoG project, as well as the roadmap for the future implementation of a sustainable value chain.

The outcomes of action B1, the first implementation action of the project have been the European handbook of best practices for controlled deconstruction of gypsum system and the European manual of best practices for the audit of building. These

documents summarize the actions and results of the deconstruction projects implemented in Belgium, France, Germany and the UK. In these countries, the partners have implemented audits to identify materials and wastes to be removed, created a catalogue with photos of the materials built 20-30 years ago and examined in detail the different gypsum-based systems deconstruction techniques. The handbooks collate and describe in detail the results from these pilot projects and also propose an assessment of the economics of deconstruction versus demolition. These handbooks also aim at becoming standard guidelines that will lead the European demolition companies to operate in an eco-efficient way, help Member States to achieve the goals of the Waste Framework Directive (WFD) and, finally, to contribute to the creation and promotion of a culture of deconstruction.

During the coming months, the GtoG Project is expected to deliver results related to the waste processing and reincorporation of recycled gypsum in the manufacturing process. For the first one, European specification/qualifications for recycled Gypsum and a handbook on waste acceptance criteria at the recycling facilities will be delivered. For the second one, the optimal European average percentage of recycled gypsum that could be incorporated in the production process, aimed at 30% in the pilot manufacturing plants, will be assessed.

Conclusions

The GtoG project is contributing to demonstrating that gypsum recycling rates can be increased and incorporated in the gypsum manufacturing process if deconstruction techniques are used in demolition and renovation works:

- The recyclability of the material at the end of its life highly depends on the way the building is deconstructed and how the material is segregated on-site.
- Local factors and criteria will determine the available options, demanding a substantial effort on behalf of the companies involved with regard to resources and investments, as well as requiring a high level of technical expertise and professionalism.
- Even if not representing additional cost or labour, changes in the stakeholders' implemented systems can be hard to accomplish. Consequently, training, education and dialogue are required.
- Selective demolition is compatible with all methods of demolition. Initial treatment and evaluation of the waste generated on-site might incur costs that will be recovered from savings on waste management and income from the recycled materials.
- Gypsum from plasterboard waste, if correctly managed, can always be recycled into new plasterboard.

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References

Barbudo, A., Galvín, A. P., Agrela, F., Ayuso, J., & Jiménez, J. R. (2012). Correlation analysis between sulphate content and leaching of sulphates in recycled aggregates from construction and demolition wastes. *Waste Manage.* (New York, N.Y.), 32(6), 1229–35. doi:10.1016/j.wasman.2012.02.005

Eurogypsum. (2012). Plaster and Plasterboard-the Sustainable Construction Materials for the 21st Century.

European commission. (2008). Construction: Green Public Procurement (GPP) Product Sheet, 1–16. Retrieved May 19, 2015, from: http://ec.europa.eu/environment/gpp/pdf/toolkit/construction_GPP_product_sheet.pdf

European Commission. (2010). Green Public Procurement Wall Panels Technical Background Report, (June). Retrieved May 19, 2015, from: http://ec.europa.eu/environment/gpp/pdf/wall_panels_GPP_background_report.pdf

European Commission DG ENV. (2011). European Commission DG ENV A project under the Framework contract, 33.

European Parliament and Council (2008). Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain directives.

The Council of the European Union. (2003). Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex to Directive 1999/31/EC (2003/33/EC). *Official Journal of the European Communities*, L 11/27.

WRAP and Environmental Resources Management Ltd (ERM). (2008). WRAP Technical Report: Life Cycle Assessment of Plasterboard.

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