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GtoG Life + Project : First steps towards a circular economy for gypsum

The European gypsum industry has long been an advocate of sustainable practices and operations. Here, Christine Marlet, Secretary General at EUROGYPSUM, describes the development of the GtoG (Gypsum-to-Gypsum) project, a collaborative project between the recycling sector, the demolition sector and gypsum producers.

Background of the GtoG project

The gypsum wallboard sector is at a unique advantage when it comes to the recycling of construction and demolition (C&D) waste because of the 'eternal' recyclability of the material it uses. By working with the construction and demolition chain, significant amounts of C&D waste can be diverted from landfill.

C&D and gypsum-derived waste streams in Europe vary by region. It is hard to obtain solid statistics, let alone predict future developments with any certainty. Under the GtoG project, and using Eurostat statistics on the production of manufactured goods in 2012, an estimation of total plasterboard waste has been calculated (See Table 1).

Applying deconstruction techniques instead of demolishing buildings will lead to improved sorting and recycling of non-load bearing elements, like gypsum wallboard, for re-use in the production process. However, the production processes must be adapted to allow increased recycled content in the new product. This requires research and development.

Deconstruction is an essential step in waste recycling feasibility and should become the standard if we want to obtain a circular economy. Deconstruction should also be applied in major and minor renovation projects. Education of the C&D workforce is

essential to create a 'deconstruction mentality.' To optimise the recyclability of gypsum waste, we need:

1. Research and development towards gypsum products and systems that ensure maximum recycling;
2. Selective deconstruction and sorting among the relevant stakeholders, especially demolishers;
3. Optimisation of the internal recycled material input capacity of gypsum manufacturing plants.

The vision of the GtoG project

The overall aim of the GtoG project is to transform the gypsum demolition waste market in order to achieve higher recycling rates of gypsum waste and thereby achieve a resource-efficient gypsum economy. This will start with the establishment of a collaborative business model between the demolition, processing, manufacturing and recycling industries. Closed-loop recycling for gypsum products will only happen if:

1. Deconstruction techniques are applied systematically for all demolition and refurbishment projects;
2. Sorting is done at the source to avoid mixed waste;

Below - Table 1: Estimation of total gypsum waste generated in 2012.

Country	Solid volume of gypsum based products (Mm ²)	Population (million)	Consumption of gypsum based products (m ² /capita)	Consumption of gypsum-based products (Mm ²)	Consumption of gypsum-based products (Mt)	New construction waste (t) (10% of total consumption)	Demolition and renovation waste (t) (50% of new construction waste)	Total gypsum based waste generated (t)
Belgium	Confidential	11.1	2.54	28.2	0.24	23,973	11,986	35,959
Germany	264.9	81.8	2.33	190.8	1.62	162,164	81,082	243,246
Greece	Confidential	11.3	1.08	12.2	0.10	10,356	5,178	15,534
Spain	100.5	46.2	1.44	66.6	0.57	56,572	28,286	84,858
France	292.7	63.4	4.49	284.6	2.42	241,956	120,978	362,934
N'lans	Confidential	16.7	2.14	35.9	0.30	30,492	15,246	45,738
Poland	105.3	38.5	1.71	66.0	0.56	56,121	28,061	84,182
UK	221.1	63.3	3.46	218.8	1.86	185,855	92,927	278,782
TOTAL	>984.5	-	-	902.8	7.67	767,488	383,744	1,151,233



Right: Recycled gypsum powder.



3. Waste is processed according to clear standards;
4. Innovative processes allow the incorporation of processed gypsum waste into new products.

The GtoG project aims to put in place an integrated approach to holistically manage C&D waste, starting from the major refurbishment/demolition sites to the reinsertion of the recycled gypsum in the manufacturing process via the processing of the gypsum waste as a secondary raw material. In order to reach this goal, surveys on waste recycling and deconstruction practices and economics were carried out in 2013 in some major European gypsum product consumers, namely France, Germany, Belgium, the Netherlands, Spain, Greece and Poland. Pilot projects towards the implementation of deconstruction and decontamination techniques, waste qualification and reprocessing in gypsum manufacturing plants is ongoing in France, the UK, Germany and Belgium. The outcomes of these pilot projects will be used to reassess the findings of the surveys carried out in 2013. The work being performed includes:

- Diagnosis of buildings before deconstruction;
- Auditing and the creation of an inventory of recyclable materials;
- Decontamination of waste if necessary and separation of different waste streams;
- Processing of the gypsum waste received;
- Qualifying gypsum waste;
- Reprocessing of the waste in plasterboard manufacturing plants (Cradle to cradle);
- Establishing the end-of-waste criteria for recycled gypsum powder.

GtoG partners

As well as Eurogypsum as project coordinator, the GtoG partners consist of: Consultants in demolition, logistics and waste management; Demolishers with in-depth knowledge of relevant demolition procedures, regulations and processes; Universities; Recyclers (including New West Gypsum Recycling and Gypsum Recycling International) and; Wall-

board producers, namely: Placoplatre SA (Saint-Gobain), Siniat SA (France), Siniat Ltd (UK), Knauf Gips KG (Germany) and Gyproc (Belgium).

Main expected results and outcomes

- Inventory of current practices for deconstruction, recycling and re-incorporation in the manufacturing of recycled gypsum;
- European Handbook of best practices for deconstruction of gypsum-based systems;
- Manual of best practices for the audit of buildings to be deconstructed;
- Specifications for recycled gypsum;
- Establish end-of-waste status for recycled gypsum.

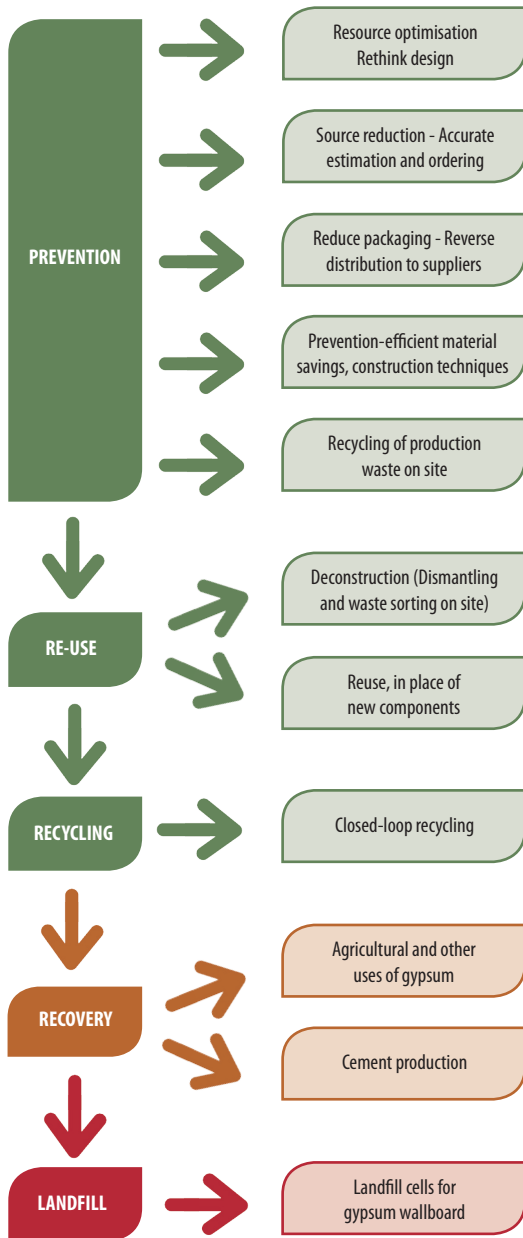
Findings on deconstruction, recycling and re-incorporation

Work towards the report into the current status of deconstruction, recycling and re-incorporation of waste gypsum material into new products was carried out between January and September 2013. Research covered Austria, Germany, Belgium, the Netherlands, France, Greece, Italy, Spain, Poland and the UK. The methodology used was a combination of literature review, questionnaires and face-to-face meetings with the partners and stakeholders involved in the supply chain.

Types of gypsum waste: There are three categories of Gypsum based-waste on origin. These are: 1. Production waste (products that are off-spec or other waste from the production process); 2. Construction waste and; 3. Demolition waste (including that from refurbishment projects). Production waste is generally recycled by wallboard producers at present. Construction waste collection and recycling has started and is increasing in Scandinavia, France, the UK and Benelux. Re-incorporation rate of the recycled gypsum in the manufacturing process differs from country to country and from plant to plant.

Gypsum material from demolition waste is currently not recycled because buildings are currently crushed, impeding the sorting of wallboard. This is compounded by the fact that buildings containing wallboard are a relatively recent phenomenon. We are only now beginning to start dismantling buildings that have wallboard linings. On top of this, gypsum demolition waste tends to be contaminated with metal, wallpaper and other materials. This renders the treatment more complex at higher cost and limits the ability to use the resulting material.

Current deconstruction practices: To properly manage C&D waste at work sites, separation of recyclable wastes must be done in-situ. This is most important in large-scales demolitions. The main obstacle currently facing the selective demolition is the fact



Above: Waste hierarchy for gypsum wallboard.

that the architects and builders did not foresee the dismantling of the building at the end of its useful life. Future designs should enable relatively straightforward disassembly in order to promote recycling of construction materials. There needs to be a change of emphasis from demolition to deconstruction.

There are considerable differences in deconstruction. In the countries where deconstruction is commonplace (the UK, France, Belgium, the Netherlands) gypsum-based wastes are generally segregated from the other waste by hand. However, in countries like Greece, Spain and Poland, wallboards and gypsum blocks are generally mixed with other construction and demolition wastes. The schemes are complex and often depend on local conditions, for example the presence (or lack) of a type of outlet in a certain area.

Legislation does not require traceability of documents. It is essential to follow waste flows not only from the jobsite to the transfer stations, but also and above all, from the transfer station to the final outlets. Thus it is recommended that legislation requires traceability documents, as the countries have to monitor the amount and quality of C&D waste in order to reach the European 70% recovery target.

There is no regulatory requirement when choosing to demolish or to deconstruct buildings in the eight target countries. Some national schemes are starting to promote on-site segregation, such as the Royal Decree 105/2008 in Spain that introduced the waste holder obligation to segregate on-site different construction and demolition waste fractions if a certain tonnage is exceeded. However, wallboard waste is not listed and only very large buildings will exceed the specified amount of waste. The regulatory audit of the materials prior to demolition in France is another

example of regulatory requirement that encourages deconstruction of buildings.

The main obstacles identified for deconstruction practices today are that most of the architects and construction companies did not foresee the dismantling at the end of the useful life of the building and that it is generally perceived as more costly.

The current drivers for deconstruction fit into three main categories. **1. Environment:** If an evaluation procedure is followed, environmentally friendly practices are usually carried out. BREEAM has been identified as the most used system in the countries under study; **2. Image of the stakeholder:** Many companies adopt an environmental approach to reinforce their environmental credentials; **3. Economics:** Deconstruction is a way of optimising costs in countries where the end route for mixed waste is more expensive than for segregated waste.

Current recycling practices: The recycling market in Europe is mature in the UK, the Netherlands, Belgium, France and Scandinavia. The average recycling rate for those countries is 19%. In other countries only production waste is recycled, giving a rate of around 5%. Most wallboard plants have simple equipment to crush production waste prior to it going back into the manufacturing process.

In terms of post-consumer gypsum wallboard recycling there are two worldwide leaders: Gypsum Recycling International and New West Gypsum Recycling. There are a variety of smaller recyclers, mainly in the UK and France. The major competitive factors for gypsum recyclers are:

- Formulation and technology innovation;
- Cost-effectiveness and pricing;
- Technical support and service;
- Alliances with distributors and key end users.

Recyclers in the mature market have state-of-the-art technology. They process gypsum and wallboard waste from construction, renovation and demolition activities for closed-loop recycling back into wallboard. The core gypsum itself is processed through a series of stages to achieve the manufacturer's specification. Great care is taken to ensure that physical impurities are removed from the material and the final product is stored in a dedicated location in order to avoid cross-contamination of gypsum powder and paper. Potential contaminants, apart from mechanical contaminants like screws, nails, paint, metal, wood, and plastics are asbestos, vinyl-based wall linings, glass fibre mesh, lead-based paints, laminates, insulation and heavy metals.

The specifications of the recycled gypsum for successful re-incorporation in the manufacturing process are key. The manufacturer will only accept recycled gypsum that is of sufficient quality to be re-incorporated into new gypsum products. This is

related both to the quality of the gypsum itself and the producer's requirements regarding trace elements that may cause adverse environmental or human health impacts.

The recycling cost of gypsum-based waste stemming from an external recycling facility is around Euro55/t. This comprises Euro10/t for transport and Euro45/t for recycling.

Current re-incorporation practices: The largest market for recycled gypsum is incorporation into new wallboard. Recycled gypsum, as with virgin gypsum, can also be used for cement manufacture, road construction, as a soil improver and stabiliser or use as a replacement for clay block manufacture.

Gypsum production waste can simply be crushed and mechanically sieved for inclusion with natural gypsum sources directly in the manufacturing plant. As the quantity of production waste is small compared to the entire input of raw material (natural and/or FGD gypsum) in many cases it is not necessary to separate paper from the gypsum core.

Re-incorporation needs further research and development when a high percentage of recycled gypsum is re-incorporated in the manufacturing process. Then the purity of gypsum becomes very important. Recycled gypsum needs further grinding to achieve a specific particle size distribution so that it will be accepted by the plant. Another parameter is the proportion of paper content in the recycled gypsum, which should be kept under 1%.

Higher recycling standards are needed for re-incorporation of recycled gypsum into a wallboard production process that uses 100% FGD gypsum. Intensive sieving is then required to obtain a grain size comparable to the particle size of FGD gypsum.

Consistency is related to supply volumes over time and the quality of recycled gypsum. Consistent volume and quality enables a uniform re-incorporation of recycled content in the final board product, effectively promoting an increase in the recycled content without damaging the manufacturing process. In the real world, producers can face over-supply or under-supply of wallboard waste-derived gypsum, which can disrupt re-incorporation into new products.

While reincorporation helps to divert waste from landfill, a recent life cycle analysis study (LCA) by WRAP, a UK government body which funds and carries out waste mitigation research, indicated that little environmental benefit is achieved through incorporating recycled gypsum into new plasterboard versus using 100% virgin gypsum material. The benefits are all less than 10% between the current product system and the product with 25% recycled gypsum for plasterboard Type A, the most common plasterboard in the UK. However, increased recycling rates do reduce the amount of materials going to landfill. This closes the loop on materials and resource consumption and, as such, is an important consideration in itself.

Conclusions

A strong cooperation within the supply chain is needed for effective closed-loop gypsum recycling. There is still a long way to go. Indeed, the business model differs between countries due to cultural factors and environmental legislative frameworks.

However there are main characteristics that are valid for any kind of construction and demolition waste recycling. Construction and demolition and gypsum-based waste recycling systems always involve more than one operator. Each operator has its own responsibilities towards the economic, technical and environmental efficiency of the recycling process.

Waste collectors can also be recyclers and recyclers can also organise the waste collection. Manufacturers can also be recyclers (having internal recycling facilities) and they can also collect waste. Some gypsum manufacturers have put in place take-back schemes for collecting construction waste.

The efficiency of the value chain also depends on the monetary value of the recycled gypsum waste. Wallboard is a commodity and has little monetary value for the waste collectors, the demolishers or the contractor. However, sorting at demolition and construction sites will happen for wallboard if:

- National authorities push for dismantling, recycling or recovering of the plasterboard waste by giving a positive legal context and appropriate incentives;
- Other types of waste of high monetary value are recovered at the same time;
- Audits of gypsum-based waste are carried out prior to demolition;
- Logistics are optimised.

Otherwise, the landfill route will still be seen as the easiest and often most economically viable route.

Next steps

Deconstruction pilot projects are being carried out in Belgium, the UK, France and Germany. Wallboard waste is being transferred to the recyclers for processing prior to transferring the recycled powder to five wallboard plants. The recycled gypsum powder used during the re-incorporation phase is being tested by the laboratory LOEMCO. The results of the test will be used to improve the existing gypsum specifications.

Economic, environmental and social indicators have been defined for deconstruction, recycling and re-incorporation. They are being used in the pilot projects. At the end of the project, best practices on deconstruction, recycling and re-incorporation of the recycled gypsum will be defined. 