Methodology for the free allocation of emission allowances in the EU ETS post 2012

Sector report for the gypsum industry

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Disclaimer and acknowledgements

Disclaimer

The views expressed in this study represent only the views of the authors and not those of the European Commission. The focus of this study is on preparing a first blueprint of an allocation methodology for free allocation of emission allowances under the EU Emission Trading Scheme for the period 2013 – 2020 for installations in the gypsum industry. The report should be read in conjunction with the report on the project approach and general issues. This sector report has been written by Ecofys.

Acknowledgements

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Table of content

1 Introduction

The gypsum industry covers the activities ranging from mining the mineral gypsum to the production of (end-use) products. Products of the gypsum industry are plaster, plasterboards (which includes a wide range of standard and specialty products), gypsum fibreboard and gypsum blocks, which are all used in the building sector (EUROGYPSUM, 2007). Gypsum is also an essential ingredient in cement production, where it is used as a retarding agent. Outside the construction industry, dried and grinded raw gypsum is called land plaster and used as a soil amendment and fertiliser. Furthermore, gypsum is used in the making of ceramic moulds, plaster cove and cornice, surgical and dental casts, as a water conditioner for beer-brewing and sugar-refining, as ingredients in flour, bread, ice-cream and pet food, and as an agent in pharmaceutical products.

The gypsum industry is explicitly included in the amended EU ETS Directive as:

> "Drying or calcination of gypsum or production of plaster boards and other gypsum products, where combustion units with a total rated thermal input exceeding 20 MW are operated."

Activities of European gypsum installations, represented by EUROGYPSUM, can potentially fall under the following NACE Rev. 1.1/ PRODCOM codes:

Table 1 NACE Rev. 1.1 and PRODCOM codes for gypsum products

NACE Rev. 1.1 code	PRODCOM code	Description
14.12		Quarrying of limestone, gypsum and chalk[1]
	14.12.10.30	Gypsum and anhydrite
26.53		Manufacture of plaster
	26.53.10.00	Plasters consisting of calcined gypsum or calcium sulphate (including for use in building, for use in dressing woven fabrics or surfacing paper, for use in dentistry)
26.62		Manufacture of plaster products for construction purposes
	26.62.10.50	Boards, sheets, panels, tiles, similar articles of plaster/compositions based on plaster, faced/reinforced with paper/paperboard only, excluding articles agglom. with plaster, ornamented
	26.62.10.90	Boards, sheets, panels, tiles, similar articles of plaster/compositions based on plaster, not faced/reinforced with paper/paperboard only, excluding articles agglom. with plaster, ornamented
26.64		Manufacture of mortars
	26.64.10.00	Factory made mortars

Continuation Table 1

NACE Rev. 1.1 code	PRODCOM code	Description
26.66		Manufacture of other articles of concrete, plaster and cement
	26.66.11.00	Articles of plaster or compositions based on plaster, n.e.c.

[1] Energy emissions from mining or quarrying are not covered by the EU ETS

Regarding the above listed NACE / PRODCOM codes, several things should be noted:

- Installations for mining and quarrying of gypsum are not covered by the EU ETS.
- Installations in the gypsum sector normally produce more than one of the products mentioned in the table.
- The products as mentioned are also produced by installations that are not regarded as part of the gypsum sector, because they also conduct other production processes not related to gypsum.
- Normally, production statistics based on PRODCOM only relate to products that are sold and not to intermediate production
- Installations in the gypsum sector might also use other PRODCOM codes when reporting production or can for a certain product choose between various codes (e.g. between mortars and plaster or between boards and articles.

Table 2 Gypsum sector in the EU ETS

	2005	2006	2007	2008
Number of installations	4	8	8	20
Allocation (kt CO_2)	91	177	177	996
Verified emissions (kt CO_2)	86	180	177	717

As shown in Table 2, only very few installations of the gypsum sector were covered in the first phase of the EU ETS. On average, they received slightly more allowances than reported emissions.

The coverage increased considerably to 20 installations in phase II. The larger number of installations is mostly due to an enlarged scope of the EU ETS in the United Kingdom. As there is no dedicated activity category for gypsum installations, Member States have included them under the category "*Energy activities – Combustion installations with a rated thermal input exceeding 20 MW (except hazardous or municipal waste installations)*".

Based on 2008 data, these installations have received on average almost 40% more allowances than emissions. The order of magnitude of the long position is similar to other industrial installations that reduced their output due to the general economic downturn in 2008. Allocation and verified emissions data per installation are given in Appendix A.

Regarding the installations and allocation numbers, it has to be noted that due to the broad definition as "combustion installations", it may be possible that some installations that belong to the gypsum sector are missing. As well, changes made to the installations or allocation

from the Member States' New Entrants' Reserve may lead to a higher allocation number than what is listed above.

The number of installations captured in phase 3 of the EU ETS from 2013 to 2020 is depending on the following issues:

- Definition of "individual equipment <3MW", which could lead to several installations fallen below the 20MW threshold.[1]
- Definition of Art. 27 requirement for "equivalent measures", as that could lead to several installations <35MW and emitting <25,000t of CO_2 per annum being exempted as small emitters.

Notwithstanding the above, EUROGYPSUM expects the number of gypsum installations captured to rise substantially. They estimate that around 50 plants could be caught in phase 3. This would represent a very significant increase in the number of plants participating in the EU ETS. Greater accuracy can be provided following a EUROGYPSUM survey of thermal capacities across EU installations.

[1] The amended EU ETS Directive states that "When the total rated thermal input of an installation is calculated in order to decide upon its inclusion in the Community scheme, the rated thermal inputs of all technical units […] are added together. These units could include all types of boilers, burners, turbines, heaters, furnaces, incinerators, calciners, kilns, ovens, dryers, engines, fuel cells, chemical looping combustion units, flares, and thermal or catalytic post-combustion units. Units with a rated thermal input under 3 MW […]shall not be taken into account for the purposes of this calculation." As some installations have dryers and burners within those dryers, the exact definition of the term "technical units" is very decisive for the calculation of the installation's thermal input. In case "technical unit" refers to the dryer, a dryer with 3 burners of 1.5 MW each will be included in the calculation. In case "technical unit" refers to the burners, the same dryer will not be included. For some gypsum plants, this definition could make the difference between being covered and not being covered by the EU ETS.

2 Production process and GHG emissions

The mineral gypsum is calcium sulphate dihydrate ($CaSO_4.2H_2O$) from a chemical point of view. The production process starts with the mining of the mineral, which is then ground to a powder. This powder can be sold as a component to cement.

Inside the gypsum production process, the powder is dried until a water content of 0.5% is reached. The resulting raw can be sold as a soil conditioner, then called land plaster. If the raw gypsum is heated ("calcined") at 150°C to 165°C, three-quarters of its combined water is removed to produce hemi-hydrate plaster ($CaSO_4,1/2H_2O$), commonly known as stucco or 'Plaster of Paris'. When this powder is mixed with water the resulting paste sets hard as the water recombines to produce gypsum again. Higher calcination temperatures produce so-called anhydrite, which has a lower reaction with water.

In a last production step, the plaster can be mixed with water and other components (additives, accelerators, etc.) to produce gypsum blocks, or, if pressed between two sheets of paper, plasterboard. gypsum reinforced with glass-fibre (Glass reinforced gypsum – GRG) is used to increase its fire-resistance.

An important alternative to the use of natural gypsum is gypsum that comes from a flue gas desulphurization plant (FGD) of the power station industry. This FGD gypsum is the end product of a wet purification procedure with natural lime, formed in the same but speeded-up process as natural gypsum. This synthetic gypsum has a higher purity (gypsum content of 96%) than most natural gypsum (80%). On the other hand, it has also a higher wet content (8-10%) than natural gypsum (1-3%), leading to a higher energy input for drying.

Emissions in the gypsum industry occur as a result of combustion processes. These combustion processes deliver the energy for three main production steps (Entec, 2006):

- Drying the raw gypsum feed (natural or synthetic) to achieve ~0.5 % moisture content
- Calcining the gypsum
- Drying of the final plasterboard product

The majority of gypsum plants use direct combustion to deliver the heat for calcining and drying. As a consequence the associated CO_2 emissions are attributed to the respective gypsum installation.

However, in some cases, CHP plants at the gypsum site also deliver energy to external customers, and other plants use indirect heat via steam that is supplied by external plants. In these cases, the CO_2 emissions attributed to the respective installation will have to be corrected for the exported or imported energy to calculate the emission intensity for the product benchmark in line with the overall approach to cross-boundary heat flows as discussed in the report on the project approach and general issues.

3 Benchmarking methodology

3.1 Background

The gypsum industry covers the activities ranging from mining the mineral gypsum to the production of (end-use) products. Products of the gypsum industry are plaster, plasterboards (which includes a wide range of standard and specialty products), gypsum fibreboard and gypsum blocks, which are all used in the building sector (EUROGYPSUM, 2007). Gypsum is also an essential ingredient in cement production, where it is used as a retarding agent. Outside the construction industry, dried and grinded raw gypsum is called land plaster and used as a soil amendment and fertiliser. Furthermore, gypsum is used in the making of ceramic moulds, plaster cove and cornice, surgical and dental casts, as a water conditioner for beer-brewing and sugar-refining, as ingredients in flour, bread, ice-cream and pet food, and as an agent in pharmaceutical products. Intermediate products are also traded amongst installations of the gypsum sector, as not all installations carry out all activities.

For the raw gypsum/land plaster stage, the CO_2 emissions associated with drying the raw material depend on the water content of the raw gypsum. Natural gypsum has a lower wet content than flue gas desulphurisation (FGD) gypsum, which means that natural gypsum is less CO_2 intensive. Natural gypsum is not available at all sites while FGD gypsum is a by-product of the cleaning of power plants' flue gases. For the plaster stage, various types of gypsum are produced by differentiating the temperature of the calcining process. Higher temperatures lead in general to a lower reaction with water. The following types can be differentiated:

Table 3 Hemi-hydrates and anhydrates and respective calcining temperatures (Datenbuch Gips 2006)

Name	Calcining temperature
α-hemi-hydrate ($CaSO_4 \bullet ½ H_2O$)	80 - 180°C (saturated steam atmosphere)
β- hemi-hydrate t ($CaSO_4 \bullet ½ H_2O$)	120 - 165°C (standard atmosphere)
α-Anhydrite III ($CaSO_4 \bullet 0{,}x H_2O$)	290°C (saturated steam atmosphere)
β-Anhydrite III ($CaSO_4 \bullet 0{,}x H_2O$)	110°C (standard atmosphere)
Anhydrite II_s ($CaSO_4$)	300 - 500°C
Anhydrite II_u ($CaSO_4$)	300 - 500°C
Anhydrite I ($CaSO_4$)	>700°C

For the final product stage, drying energy and associated CO_2 emissions vary between product types, regarding their form (gypsum blocks, plasterboards, glass-fibre reinforced gypsum (GRG) boards), additives (different inert materials for fire, water or sound characteristics) or thickness.

3.2 Final proposal for products to be distinguished

In accordance with the criteria for product differentiation as mentioned in the report on the project approach and general issues (Chapter 4), separate benchmarks could be distinguished if the difference in benchmark emission intensity is substantial (20% is mentioned as threshold) and if the different products can be well differentiated using accepted and unambiguous product classifications. Because of the trade in intermediate products, also with installations not covered by the EU ETS, and in accordance with the principle to have different benchmarks for intermediate products if these products are traded between installations" [report on the project approach and general issues, Chapter 4], it is necessary to determine benchmarks for all stages of the gypsum product chain. This means that benchmarks should be determined for the raw gypsum/land plaster (the principle product dehydrate gypsum sold after drying), the plaster (after calcining) and the gypsum block or plasterboard stages.

In their reply to the interim report, EUROGYPSUM proposed to use eight product benchmarks for the gypsum sector, as shown by Figure 1:

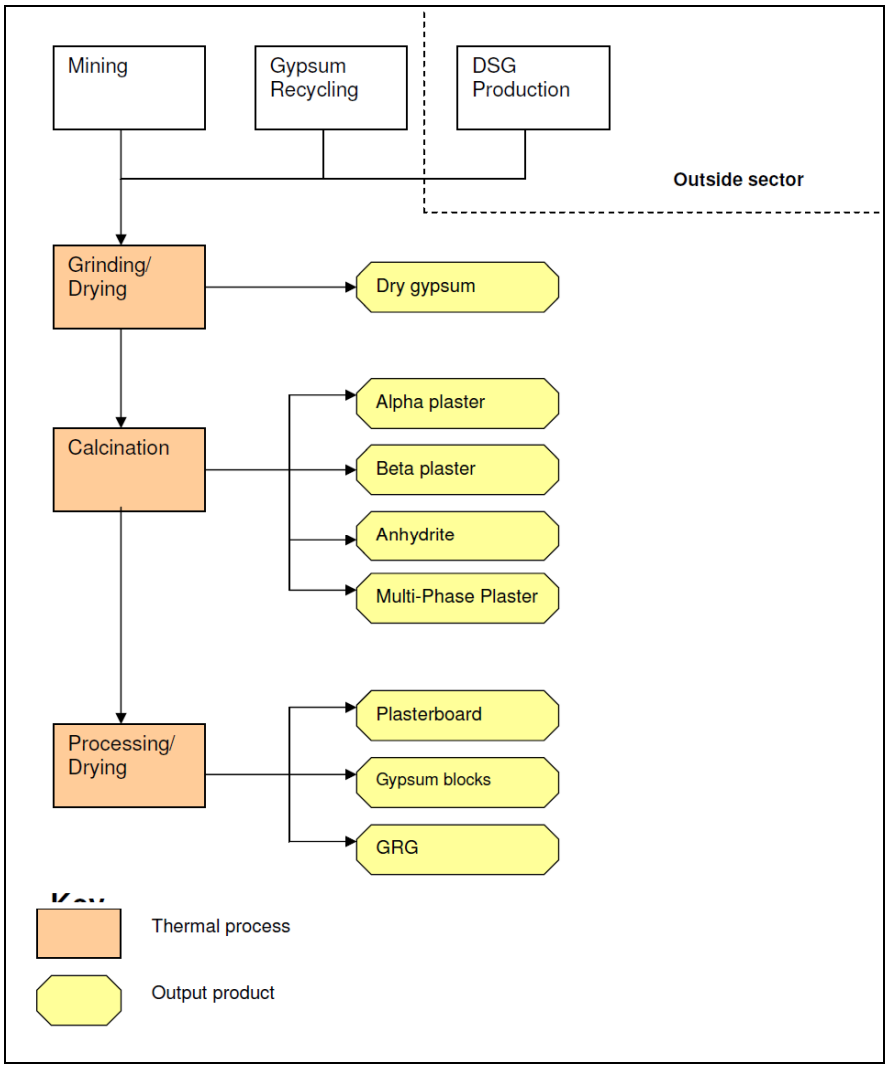

Figure 1 Benchmark differentiation proposed by EUROGYPSUM (Eurogypsum, 2009)

To assess the need to differentiate between eight different gypsum products, two issues have to be solved:

1. Product groups have to be clearly distinguishable and well defined.
2. Relevant emissions and production data for each product group have to be available.

Regarding the first issue, it has to be noted that while some plaster products can be clearly categorized as α-plaster, β-plaster, anhydrite or multiphase plaster, the gypsum industry can produce plasters over the whole spectrum of technical specifications. Therefore, and because different technologies are applied for the very similar products (Datenbuch Gips, 2006), emission intensities of products are expected to be merely distributed over a large spectrum than clearly cut into groups. A differentiation into product groups seems to be further complicated by the different market shares of products in national markets.

Even if product groups can be clearly defined in theory, it would be difficult to ensure that production is correctly reported under each group by manufacturers, as PRODCOM or other official categorization nomenclatures are hardly useful to differentiate between intermediate products (alpha plaster, beta plaster, anhydrite, multiphase plaster are differentiated by process temperature and related physical attributes of product).

Regarding the second issue, so far the only data available and reliable is contained in (Entec, 2006). This report gives data for four instead of eight product groups. It has to be noted that this report is solely based on data for the United Kingdom, which might not be representative for the whole EU gypsum sector.

As an alternative to the default output based benchmark, allocation benchmarks for the gypsum sector could be based on input mass data for the process steps of drying the raw gypsum and calcining the raw gypsum to plaster. Benchmarks for final products such as gypsum blocks and plaster boards should be based on output data, as is shown in Table 4.

Table 4 Benchmark basis per gypsum product group

Process step	**Benchmark**
Raw material drying to gypsum	Raw gypsum input
Calcining to alpha plaster	Raw gypsum input
Calcining to beta plaster	Raw gypsum input
Calcining to anhydrite	Raw gypsum input
Calcining to multiphase plaster	Raw gypsum input
Drying to gypsum blocks	Product output
Drying to plasterboards	Product output
Drying to GRG	Product output

The reasons for this are as follows:

- As gypsum is processed in the form of powder as an intermediate product, it is much easier and common practice to measure input volumes than output volumes after grinding/drying and calcining.
- Due to the above mentioned reason, there are historical data on input mass and specific thermal energy available.
- Raw gypsum is traded commercially much more often than gypsum at intermediate product. Therefore, incoming gypsum is more accurately measured than stored or outgoing gypsum that is transferred within a company.
- Ratios between input and output mass are related to the type of intermediate product (processing, additives) but are in general well known at installation level.
- The addition of inert materials after the calcination step is confidential information for the three main companies of the sector, as this is the main criteria of differentiation between products and companies.

If it can be shown that input-to-output ratios are consistent for different products, applying input-based benchmarks, whether directly or indirectly via default conversion factor for input to output mass could in principle be considered.

Given the issues discussed above regarding differentiation and data availability, to our knowledge, the only available public source of energy or emissions data for products of gypsum products is the new entrant benchmark report for the UK (ENTEC, 2006). Based on the information in that study, it is proposed to develop benchmarks for the following gypsum products based on production output:

- Dry gypsum / land plaster (after drying of raw gypsum input) – *PRODCOM code could not be identified, probably part of 14.12.10.30, to be resolved*
- Plaster (after calcining; no differentiation between different types) – PRODCOM 26.53.10.00 and 26.66.11.00
- Gypsum blocks, plasterboards and coving (after drying to final product; no differentiation) – PRODCOM 26.62.10.50
- Glass-fibre reinforced gypsum (GRG) plasterboards – PRODCOM 26.62.10.90

As the benchmarks differentiate mostly between process steps (drying of raw gypsum, calcining to intermediate products, drying to final product), it seems possible to achieve a clear and transparent differentiation and definition of these product groups. The PRODCOM codes noted above might be used for this, but it is not sure at the moment that the PRODCOM definitions are sufficiently comprehensive and exclusive, especially regarding the differentiation between plasterboards and GRG plasterboards.

4 Benchmark values

4.1 Background and source of data

At the moment EUROGYPSUM is having relevant energy, emissions and production data collected by a third party. Until results are available, the only data source available is the ENTEC report, which itself uses information from a 1993 US EPA report (US EPA, 1993).

Benchmark values differentiated in the ENTEC report are given in kWh/ton. For benchmarks in t CO_2/ t, a fuel-and generation-specific emission factor has to be applied.

Based on the ENTEC report as well as other sources and information from the sector, natural gas is assumed to be the standard fuel for gypsum plants. Furthermore, it is assumed that the natural gas is burned and the heat directly fed into the gypsum process, which means that no additional factor representing the energy efficiency of the process has to be applied.

Based on Commission Decision (2007/589/EC) on the monitoring and reporting guidelines for the EU ETS, the CO_2 emissions factor of natural gas is 56.1 tons of CO_2 per GJ.

4.2 Final proposed benchmark values

In general, differences in emission intensity of gypsum products are caused by

- The raw material used (natural or FGD gypsum, with the natural gypsum leading to lower emissions because of lower water content),
- The calcination temperature applied (with higher temperatures leading to higher emissions and a lower reaction with water),
- The final product made (plaster, blocks, plasterboards or GRG boards with varying formats; higher emissions due to higher drying energy needs).

Until actual European data is provided, the results from ENTEC (2006) allow the proposal of the following benchmark values for the gypsum sector:

- Dry gypsum / land plaster: 0.20 GJ / t → 0.01 t CO_2 / t
- Plaster 0.85 GJ / t → 0.05 t CO_2 / t
- Gypsum blocks, plasterboards and coving: 1.49 GJ / t → 0.08 t CO_2 / t
- GRG plasterboards: 3.25 GJ / t → 0.18 t CO_2 / t

These values are based on the values of best performing plants in the UK in the middle of the decade. It is consistent with values found for US gypsum plants. The value for dry gypsum assumes moisture content of 6 weight % and is an average value based on an estimated fuel requirement of 0.033 GJ / t per weight % of moisture content.

It should be noted that these values might not be representative for European plants, especially as regional production and consumption patterns differ widely according to EUROGYPSUM.

Furthermore, it should be noted that benchmark values of the ENTEC report are related to the mass of produced output and does not consider the option to use input units for dry gypsum / land plaster and plaster stages.

4.3 Possibility of other approaches

If it can be demonstrated that there are no considerable losses of gypsum material throughout the production process and differences in additives for a specific product (group) are marginal regarding associated CO_2 emissions, a benchmark based on raw gypsum input data could be applied for all intermediate products. This would not be in line with the general approach to base benchmarks on product output, but would have advantages regarding data collection and accuracy.

The input of raw gypsum (calcium sulphate) will then have to be measured for each of the respective benchmarked intermediate products separately.

Due to the limited emissions and the complexity of the sector (variety of (intermediate) products) a fall-back approach as elaborated on in Chapter 5 of the report on the project report and general issues could also be envisioned.

5 Additional steps required

As mentioned above, data on energy, emissions and production volumes per product could not be obtained from the gypsum sector, represented by EUROGYPSUM, so far. The benchmark values as proposed here for that reason have a narrow basis.

These data are critical to assess the differentiation of benchmarks for products as well as benchmark levels based on the best performing installations. Data are currently gathered within the gypsum sector, and hopefully the results will be available within time to develop representative gypsum benchmarks at a later stage. The data could also be used as a bottom-up verification of the proposed benchmark values in this study and could further clarify whether the necessary production data are available. In such verification step, the use of input rather than output data would could be elaborated in more detail to assess potential advantages and drawbacks of such a method and the correct product definitions (PRODCOM in combination with classifications in use by the sector) should also be further assessed.

Although concerns by the sector regarding data confidentiality and anti-trust issues are acknowledged, it should be noted that official benchmark rules and values for each sector as well as final allocations per installation will ultimately become available.

6 Stakeholder comments

Comments to an interim version of this report have been received via the following communications:

- Attachment to e-mail from EUROGYPSUM on 2009-07-01: "090701 – Eurogypsum comment on first Ecofys rep on gypsum benchmark"
- Attachment to e-mail from EUROGYPSUM on 2009-07-03: "Ecofys Initial Report on Gypsum Sector Benchmarking May 09 amended"
- Attachment to e-mail from EUROGYPSUM on 2009-08-03: "2nd Written Response to Ecofys regarding benchmarking report July 2009"

These inputs have all been included in the main text of this report (e.g. the proposal for eight product benchmarks and the use of input rather than output variable).

7 References

Bundesverband der Gipsindustrie (2006), Datenbuch Gips, Darmstadt.

Entec (2006), *EU Emissions Trading Scheme Phase II – Review of New Entrants' Benchmarks – Gypsum*, Report Version Two

Website of the European Commission, DG Competition http://ec.europa.eu/competition/mergers/cases/index/nace_all.html, visited on May 12th, 2009.

Eurostat (2008), *PRODCOM list 2008*.

EUROGYPSUM (2007) *Gypsum factsheet*.

EUROGYPSUM (2009) Eurogypsum comments on first Ecofys report on gypsum benchmark

U.S. EPA (1993) *Emission factor documentation for AP-42 sector 11.16 – Gypsum Manufacturing*.

Appendix A: List of EU ETS installations in the gypsum industry

Allocation and verified emissions of gypsum installations 2005-2007; all values rounded (Source http://ec.europa.eu/environment/climat/emission/citl_en.htm)

Reg. code	Company	Name	Instal. .ID	Main activity type code	Allocation 2005 [1000 EUAs]	Verified emissions 2005 [ktons]	Allocation 2006 [1000 EUAs]	Verified emissions 2006 [ktons]	Allocation 2007 [1000 EUAs]	Verified emissions 2007 [ktons]
BE	Saint-Gobain Gyproc	BPB Belgium	630	1	0	0	0	0	0	0
DK	Knauf	Danogips A/S	344	1	25	27	19	32	19	30
DK	Saint-Gobain Gyproc	Gyproc A/S	345	1	25	17	19	18	19	18
ES	Knauf	Knauf GmbH - Planta de Escúzar	861	1	0	0	0	0	0	0
ES	Saint-Gobain Gyproc	Saint-Gobain Placo Iberica S.A	874	1	0	0	22	20	22	19
ES	Knauf	Knauf GmbH - Planta de Guixers	951	1	0	0	32	22	32	22
ES	Yesos Ibericos	Yesos Ibéricos, S.A	1030	1	0	0	44	37	44	39
IE	Saint-Gobain Gyproc	Kingscourt Works	2	1	41	46	41	52	41	50
Sum					**91**	**86**	**177**	**180**	**177**	**177**

Allocation and verified emissions of gypsum installations 2008 (Source: http://ec.europa.eu/environment/climat/emission/citl_en.htm)

Reg. code	Company	Name	Instal. .ID	Main activity type code	Allocation 2008 [1000 EUA]	Verified emissions 2008 [ktons CO_2eq]
BE	Saint-Gobain Gyproc	BPB Belgium	630	1	45	49
DK	Knauf	Danogips A/S	344	1	21	27
DK	Saint-Gobain Gyproc	Gyproc A/S	345	1	17	17
ES	Knauf	Knauf GmbH - Planta de Escúzar	861	1	29	0
ES	Saint-Gobain Gyproc	Saint-Gobain Placo Iberica S.A.	874	1	18	14
ES	Knauf	Knauf GmbH - Planta de Guixers	951	1	21	20
ES	Yesos Ibericos	Yesos Ibéricos, S.A	1030	1	38	35
GB	Lafarge	Lafarge Plasterboard - Portbury	942	1	91	68
GB	Lafarge	Lafarge Plasterboard - Ferrybridge	943	1	49	24
GB	Knauf	Knauf Sittingbourne	978	1	65	56
GB	Knauf	Knauf Immingham	979	1	79	48
GB	Saint-Gobain Gyproc	Barrow Works	1009	1	49	36
GB	Saint-Gobain Gyproc	Sherburn Gypsum Works	1011	1	100	36
GB	Saint-Gobain Gyproc	Robertsbridge Gypsum Works	1012	1	52	29
GB	Saint-Gobain Gyproc	Kirkby Thore Gypsum Works	1013	1	99	57
GB	Saint-Gobain Gyproc	East Leake Gypsum Works	1014	1	136	77
IE	Saint-Gobain Gyproc	Kingscourt Works	2	1	49	35
SE	Saint-Gobain Gyproc	Gyproc AB	791	6	0	25
SE	Knauf	Knauf Danogips GmbH	795	6	0	22
NO	Norgips Norge AS	Norgips Norge AS	52	1	37	40
Sum					**996**	**717**
Sum corrected[1]					**966**	**670**

[1] 'Sum corrected' excludes entries where either allocation or verified emissions data is not available.