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GYPSUM END-OF-LIFE BEST PRACTICE INDICATORS

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1. Introduction –The use of indicators has become in recent years as a reliable method of evaluation for the decision-making processes [1]. Indicators give quantitative, qualitative or descriptive information about an item and or process [2], to ease the decisions that will be taken on the basis of their results, in order to optimize the processes that are being measured identifying changes and improvements [3].This study presents a set of Best Practice Indicators (BPIs) aiming to increase the amount of gypsum waste capable of being recycled, as well as to maximize the quality and percentage of recycled gypsum that can be reincorporated in the manufacturing process. Thus, the practices implemented through the whole End-of-Life (EoL) of gypsum plasterboard have been assessed. That is to say, from the deconstruction dismantling, through the gypsum waste processing, to the resulting recycled gypsum reincorporation into the manufacturing process. Key Performance Indicators (KPIs) are formulated and used to monitor and compare the five pilot projects conducted in the framework of the Life+ GtoG Project "*From Production to Recycling, a Circular Economy for the European Gypsum Industry with the Demolition and Recycling Industry".*

2. Methods –The first part of the methodology consists on identifying key areas of influence to be measured from previous preparatory actions, where a thorough review on existing literature, questionnaires distributed among European stakeholders and the gypsum recycling business model are analysed. Such influencing areas correspond to four categories: economic (ECO), social (SOC), environmental (ENV) and technical (TECH); divided into each of the stages part of the deconstruction, recycling and reincorporation process (Table 1). The classification enables the development of specific indicators per stage and thus precise parameters, which facilitates their use and individual evaluation in a classification breakdown for a more effective analysis.
According to this, a first approach of potential Key Performance Indicators (KPIs) and monitoring parameters is produced. Being parameters the variables that combined in an equation compose the indicator and enable the data collection, according to the recycling indicator they are addressing.
With the KPIs defined, application and interpretation of results is carried out by applying the same in five pilot projects set in five distinct national contexts: Belgium, two in France, Germany and the United Kingdom.

3. Results and Discussion– After data collection and analysis, a set of 37 KPIs is finally generated and refined, out of which best practice indicators (BPIs) are selected, specifically aiming to recognize and encourage best practices through the whole EoL, associated to quantitative or qualitative evaluation criteria, in order to show the degree of compliance with a minimum level of performance. Table 1 shows the final 29 selected as BPIs.

Whilst for deconstruction and recycling there are several socio-economic BPIs that have not been selected, mainly due to their variability depending on the different market context, policies and competitive environments from the country under study; in the case of reincorporation all of them are considered.

CATEGORY	STAGE	DECONSTRUCTION BPIs
TECH	Audit	TECH1. Existence and deviation of the audit for gypsum systems
	Deconstruction	TECH2. Effectiveness of the deconstruction process
	Traceability	TECH3. Effectiveness of the traceability
ENV	End route	ENV1. Gypsum waste sent to landfill
		ENV2. Transport emissions comparison between recyclnig and landfilling
SOC	Deconstruction	SOC4. Training of the deconstruction team
		SOC5. Follow-up of the waste management
ECO	Traceability	ECO4. Cost difference between recycling GW and landfilling route
CATEGORY	**STAGE**	**RECYCLING BPIs**
TECH	Storage	TECH1. Required space for storage the gypsum waste
	Reception	TECH2. Quality of the gypsum waste received
		TECH3. Gypsum waste rejected
	Processing	TECH4. Output materials of the recycling process
ENV	Processing and transport	ENV1. CO_2 Emissions from the recycling process
		ENV2. Natural gypsum saved
SOC	Reception	SOC1. Recycler's satisfaction
CATEGORY	**STAGE**	**REINCORPORATIOIN BPIs**
TECH	Reception	TECH1. Recycled gypsum rejected by the manufacturer
		TECH2. Recycled gypsum quality criteria
	Storage	TECH3. Recycled gypsum required space for storage
	Reincorporation	TECH4. Recycled gypsum content
		TECH5. Recycled content increase
	Production	TECH6. Production waste
ENV	Preprocessing	ENV1. CO_2 emissions: business-as-usual compared to maximized recycled content in the pre-processing
	Manufacturing	ENV2. CO_2 emissions: business-as-usual compared to maximized recycled content in the production process
SOC	Manufacturing	SOC1. Manufacturer's satisfaction
ECO	Reception	ECO1. Cost difference between business-as-usual and maximized recycled content quality check
		ECO2. Cost difference between natural gypsum and recycled gypsum
		ECO3. Cost difference between FGD gypsum and recycled gypsum
	Preprocessing	ECO4. Energy cost difference between business-as-usual and maximized recycled content in the pre-processing
	Manufacturing	ECO5. Energy cost difference between business-as-usual and maximized recycled content in the production process

*Indicators rejected : A) Deconstruction: SOC1. Labour time difference between dismantling and demolishing plasterboard, SOC2. Labour time difference between dismantling and demolishing gypsum blocks, SOC3. Productivity, ECO1. Audit cost, ECO2. Plasterboard dismantling and loading cost, ECO3. Gypsum block dismantling and loading cost. B) Recycling: ECO1. Energy cost of the gypsum waste processing, ECO2. Transport cost of the recycled gypsum. C) Reincorporation: None.

Table 1 Best practice Indicators

3. Conclusions - To assess the sustainable performance of the gypsum value chain the different stages part of each of the constituting processes have to be considered, classified into common technical, environmental, social and economic categories.

A total of 29 indicators have been selected out of 37 initial KPIs defined, recognizing and encouraging the implementation of best practices (BPIs).

The defined analytical framework can be used as a decision-making tool helping to increase the effectiveness of the gypsum EoL recycling route, measuring the performance and progress of gypsum waste management, detecting the possibilities of improvement as well as monitoring changes over time.

References

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