

It is possible to economically upcycle recycled aggregates

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Abstract

The waste management is a pregnant problematic in the European continent and in France too. The new paradigm called circular economy aims to be driver for the waste valorization. This objective is particularly applied in the civil engineering, the first generator of CDW (Construction and Demolition Waste) in France.

In this context, except the eco-construction, the recycling or reusing is currently necessary for the CDW valorization. But, the economic criteria such sell price or manufacturing cost are brakes to facilitate the waste valorization. In addition, using the waste is confronted to standards and NIMBY (Not In My BackYard).

To lift these brakes, the waste upcycling allows producing high quality materials from CDW. This choice seems to be a relevant orientation in terms of economic and technology. For further details, the recycling plant can produce high quality materials with a sell price more competitive than the high quality raw materials. This economic advantage can guarantee the investment necessary to set up this kind of plant.

For example, the Esterel group has chosen this orientation since several years. The obtained results of the materials valorization are compared to the results from a study realized by the French energy agency.

Finally, this comparison allows concluding about the relevancy of the CDW upcycling, which can be economically sustainable.

Keywords: waste management, CDW, upcycling, economic, technologic process.

Introduction

The waste management is a pregnant problematic in the European continent and in France too. In 2012, 246.7 million tons of CDW were officially produced in France [1]. The circular economy is driver for the waste valorization, and is particularly relevant for the civil engineering, the first generator of CDW in France. In this context, except the eco-construction, the CDW valorization based on recycling or reusing can reduce environmental pressure [2].

However, brakes such as not a priority for the clients, lack of treatment facilities induce a down-cycling option such as roadfill [3]. To boost CDW recycling such as, new recycling techniques and plants are necessary to improve quality certification of recycled aggregates, and public perception [4].

But the reuse of materials in the industrial field can be divided into three categories [5]: i) Cascading converts consumed material to a lower quality; ii) Recirculation reuses non-consumed material in a process; iii) Upgrading returns the consumed material to a higher quality, which is called upcycling.

After have defined upcycling, an industrial practice is illustrated with the plant of the French Esterel group. A perspective of the plant of Esterel group through a study driven by the French energy agency shows how the valorization option for CDW can be enlarged.

Definition of upcycling

Upcycling process aims to convert waste materials into new materials with higher quality or higher environmental value in order to reduce the consumption of raw materials [6].

Two dominant viewpoints are identified: 1) Material recovery in order to maintain value and quality of materials safely in their second life or even the improved recycling; 2) Product (re)creation for higher values and qualities by transforming waste or used materials either by companies or by individuals.

According to Sung [7], although drawbacks and barriers of up-cycling are depending on types of industry, and contextual situations, benefits can be environmental (e.g. solid waste reduction, landfill space saving,), economic (e.g. cost savings and new profit opportunities) and social (e.g. psychological well-being and socio-cultural benefits).

Upcycling in practice

1. Presentation of Esterel group

After a quarrying activity, Esterel group is today specialized in demolition/earthworks and recycling of inert materials on its site (figure 1). The activity of CDW valorization has modified the economic strategy demanding an investment for the procurement of the necessary equipment.

Figure 1. View of Esterel group site in the Esterel massif near Fréjus (France).



About 100 kt/y of inert waste are treated by a process with a recovery ratio equal to 98% and with high quality. Indeed, the sand produced by this plant has the CE2+ European certificate [8].

2. Description of the recycling plant

Process of CDW in waste management plants is based on the following objectives: i) Separation of mixed waste fractions; ii) Crushing, grinding and sorting to achieve defined grain sizes and thus marketable products.

The choice of best techniques and their configuration is challenging. This depends on technical, legal and economic aspects [9]. The objective of doing upcycling needs to apply an

optimization of every step constituting the process of valorization. These design guidelines are noticeable through the process of the Esterel group plant (figure 2).

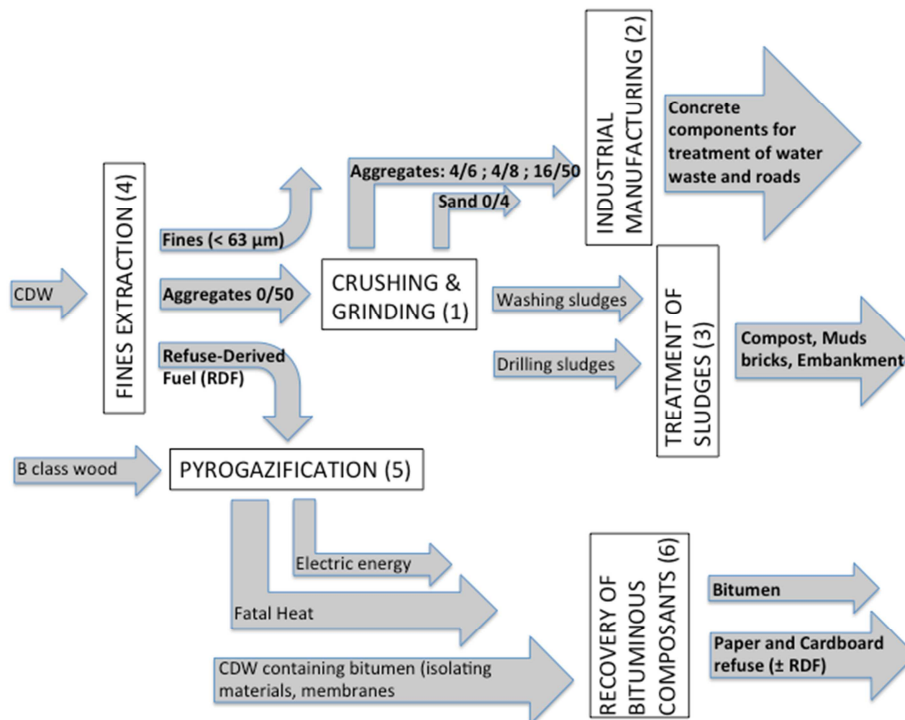


Figure 2. Synoptic of the waste valorization process carried out by the Esterel group. The six are located in the process. The inputs of the process are four: CDW, B class wood, CDW containing bitumen and drilling sludge. The outputs (in bold) are marketable or can be useful for the process.

The valorization process is composed of six steps. The major unit (1) is the step of crushing, grinding and sorting. This produces recycled aggregates, with several sizes, high quality recycled sand, and sludge generated by the sorting process.

In order to ensure the complete valorization of recycled aggregates, a manufacturing step (2) produces concrete components for the water waste networks and used for roadside. This step is carried out by a Demler DL 200 press. Then, the treatment of sludge (3) is another manufacturing step. Compressed Earth Blocks (CEB) and roadfill earth are obtained by a press filter and multi-blocks press.

To facilitate the treatment of CDW along the process, a step of fines extraction (4) is set up in the beginning of the valorization process. A pre-treatment of CDW upstream makes possible to have an optimized process sizing. The extraction of fines contained in CDW in the input of the process induces a downsizing of the equipment dedicated for the sludge treatment. And Refuse Derived Fuel (RDF) is obtained as the output of this step. Thus, an energy valorization with this RDF and B class wood can be realized by a pyrogazification step (5). Finally, the heat generated is used for the recovery of bitumen (6) constituting the components of building waterproofing.

Thus, one can identify three steps classified in the upcycling process: 1) Production of high quality sand [8]; 2) Production of CEB because earth waste and sludge become earth construction materials; 3) Recovery of RDF [10] in order to obtain a useful energy for the process.

3. Esterel group plant among French recycling plant

A study driven by the French energy agency [11] highlights two observations: 1) The French current valorization rate equal to about 50% is inferior to the objectives of the Waste Framework Directive 2008/98/EC (WFD); 2) the complexity of the waste valorization process fosters the received amount of waste (e.g. the plants having an elaborate process receive in mean 177kt/y, while the plant having a more simple process receive in mean 35 kt/y).

These observations mentioned in this report are confirmed by the example of Esterel group. CDW has therefore gained increasing interest from both a waste management and a resource efficiency perspective. Consequently, the Esterel group plant demonstrates that a sophistication level of waste treatment process is economically sustainable.

Conclusion and Perspectives

Upcycling is the choice in order to develop the reuse of CDW and to avoid the environmental pressure (decrease of landfilling, saving of natural resources or raw materials).

However, this choice is taken still too little. Indeed, the report of the French energy agency observes that the valorization rate of CDW is weak in weak the WFD objectives. The drivers such as legal objectives are a way to have an increase of technological level of recycling plant. A key parameter is a more complex process of recycling plant. The valorization rates of CDW may be increased undoubtedly. The example of Esterel group demonstrates that the R&D investment can boost the CDW recycling. And if the industrial aim is to produce high quality materials, so an economic success can be achieved. Thus, it enables to demonstrate that it is possible to economically upcycle recycled aggregates and CDW.

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