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Market analysis of recycled sands and aggregates in North-West Europe: drivers and barriers

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Abstract. Construction and demolition wastes (C&DW) are estimated at one third of total wastes generated in the European Union (EU) and represent the main flux in volume. Inert materials (e.g. concrete, bricks, tiles and ceramics) constitute the largest fraction of construction and demolition wastes. These wastes can be recovered as secondary raw materials after a recycling process resulting in the production of recycled sands and aggregates (RS&A). The market for RS&A is however complex and sensitive. It can be affected by many parameters and may be very variable from one region to another. A quantitative analysis of some market variables is carried out in five NW European countries: Belgium, France, Germany, Luxembourg and the Netherlands. For achieving this analysis, attention is paid to the following data/parameters: generation of inert construction and demolition wastes, production of RS&A and production of natural sands and aggregates. Since the market of recycled products is also governed by transportation costs, the study has compiled data on the density of recycling plants for construction and demolition wastes, the density of pits and quarries extracting natural materials, the density of inert landfills and taxes applied for C&DW landfilling. National/regional legislation and requirements are also included in the analysis. Based on the compiled data and objective reasons, the market of RS&A is more developed and more suitable in the Netherlands and in Flanders (North of Belgium) than in the other investigated countries/regions.

Keywords: market, construction and demolition wastes, recycling, sands, aggregates, Europe.

1. Introduction

In 2014, the EU-28 countries produced a total amount of 2,503 million tonnes (Mt) of wastes by all economic activities and households [1]. The construction industry accounts for one third of all the generated wastes and consists of one of the heaviest and most voluminous waste stream in the EU. Construction and demolition wastes (C&DW) represent an amount of about 850 Mt generated every year by the EU-28 or 1.7 tonne produced per year and per EU inhabitant. In the other side the annual

European demand (EU-28+EFTA) in aggregates amounted to 2,700 Mt in 2015. The European demand represents about 10% of the global demand in aggregates [2].

The market of recycled sands and aggregates (RS&A) needs to be healthful at country scale to foster Member States to reach the target defined in the Waste Framework Directive (2008/98/EC). The most cited drivers that can boost C&DW recycling are: Green Public Procurement, taxation on C&DW landfilling, taxation on natural sands and aggregates, availability and cost of natural sands and aggregates, quality certification of RS&A, better public perception and increased consumer acceptance and low distance with C&DW recycling plants (e.g. [3]).

This study focuses on three main key parameters that influence the market of recycled materials: the landfill of inert C&DW, the challenge with primary raw materials and the availability of inert C&DW recycling plants. The market context is investigated in five NW European countries (Belgium, France, Germany, Luxembourg and the Netherlands) towards a quantitative analysis of the generation of C&DW, the production of natural and RS&A, the density of recycling plants, the density of extraction sites for natural materials, and C&DW landfilling legislation.

2. Market context

Table 1 presents the results of a quantitative analysis carried out on key parameters that influence the market of RS&A, for the five investigated NW European countries. Attention has been paid to provide the most current available data. Some actors of the market of RS&A have also been visited, in the framework of the NWE Interreg project SeRaMCo.

C&DW are usually mainly composed of CBTC (concrete-bricks-tiles-ceramics), and in smaller proportions, bituminous materials, metals, wood, plastics and others. These materials are usually sorted and recycled in facilities devoted to produce RS&A. These secondary products are mainly used for road infrastructures and backfilling applications.

Excavated soils and stones are also often considered as C&DW. These excavated materials are far to be negligible in terms of weight since they usually compose more than half of the total C&DW produced at country scale. However, from a legislative point of view, excavated materials are usually considered differently from other C&DW. For example, the ban for inert C&DW landfilling is not applied to excavated soils and stones in Belgium. This ambivalent status for excavated materials entails confusion in the published national statistics related to C&DW production. Some countries include the amount of excavated materials in the quantity of generated C&DW while others do not consider this fraction in their annual statistics. Another source of confusion in national statistics pertains to the production of RS&A. Some countries include the materials recycled on-site and recovered on the same site in the amount of recycled products, while other countries only consider C&DW treated in recycling facilities, as it is the case in France.

2.1. Belgium

In Belgium, the three regional governments (Flanders, Wallonia and Brussels-Capital) are almost fully competent regarding C&DW management and recycling. These topics are not coordinated or harmonized amongst regions in a mandatory manner.

In Flanders, C&DW represented 15 Mt in 2014 [5]. The major amount of C&DW materials is composed of 40% of concrete (reinforced and unreinforced), 40% of masonry and 12% of asphalt [6]. Wallonia produced between 5 to 7 Mt of inert C&DW in 2013 [7]. Estimations at regional scale show that these inert wastes are subdivided into 25% of unreinforced concrete, 13% of reinforced concrete, 45% of mixed wastes and 11% of asphalt [8]. In the Brussels-Capital Region, inert C&DW generated account for 480,000 tonnes [9]. At national scale, it can be estimated that 22 Mt (excluding excavated soils) are annually generated in Belgium (Table 1).

According to regional decrees, recycling of inert C&DW has become an obligation since 1998 and 2006 in Flanders and in Wallonia, respectively.

More than 16 Mt of RS&A were produced in 2016 in Belgium. The total amount of certified production plants of recycled aggregates approaches 350 in the country [9]. About 80% are fixed

Table 1. Quantitative data on the market of recycled and natural sands and aggregates in NW European countries. Abbreviations: C&DW = construction and demolition wastes; CBTC = concrete-bricks-tiles-ceramics; N/A = not applicable; RS&A = recycled sands and aggregates; modified from [4].

		Belgium				France	Germany	Luxembourg	Netherlands
		Flanders	Wallonia	Brussels	Total				
Waste production	Quantity of inert C&DW excl. soils and stones (in Mt/yr)	15	5-7	0.5	~22	64	83.5	0.5-0.6	23.2
	Quantity of inert C&DW excl. soils and stones (in t/capita)	2.3	1.4-2.0	0.4	~1.9	1.0	1.0	0.9-1.0	1.4
	Quantity of CBTC (in Mt/yr)	12.6	4.1-5.7	0.4	17.1-18.7	~38	54.6	0.25-0.3	19-20
	Quantity of CBTC (in t/capita)	2.0	1.1-1.6	0.3	1.5-1.6	~0.6	0.7	0.4-0.5	1.1-1.2
RS&A production	Quantity RS&A (in Mt/yr)	13	3.5	~0	16.5	21.4 ^a	66	1.8 ^b	18 ^c
	Quantity RS&A (in t/capita)	2.0	1.0	~0	1.5	0.3 ^a	0.8	3.1 ^b	1.0 ^c
	Proportion of RS&A compared to the quantity of inert C&DW (excl. soils and stones) (in %)	87	50-70		~75	33 ^a	79		78 ^c
	Proportion of RS&A compared to total production of sands & aggregates (in %)	46	6		18-20	7 ^a	13		18-25 ^d
Landfilling	Ban for inert C&DW landfilling	Yes	Yes	N/A	N/A	No	No	No	Yes
C&DW recycling plants	Number of recycling plants	~200-250	~100		~350	~400	2,073	~30	~150
	Type of facilities				80% stationary, 20% mobile			Mainly mobile	35% crushing, 20% sorting, 45% crushing & sorting
	Density of recycling plants (per 1,000 km ²)	~16	~5		~11	~0.6	~6	~12	~4
Natural aggregates and sands production	Quantity of natural aggregates and sands (in Mt/yr)	15	55-60	0	70-75	300	450	~1	55-80 ^d
	Quantity of natural aggregates and sands (in t/capita)	2	15-17	0	6-7	4-5	5	~2	3-5 ^d
	Number of extraction sites				~200	~2,300	~3,000	~13	~295
	Density of extraction sites (per 1,000 km ²)				~7	~4	~8	~5	~7

^a The French production of RS&A is largely underestimated since the quantity of on-site recycled materials is not taken into account in the national statistics and is difficult to estimate accurately.

^b The referred quantity of RS&A in Luxembourg is largely overestimated since it includes excavated soils and stones.

^c The referred quantity of RS&A in the Netherlands is produced by BRBS's members (national federation of C&DW recyclers). This quantity could be slightly underestimated.

^d The referred data is calculated for the regular extraction activity of natural materials in the Netherlands.

installations and 20% are mobile plants. In Wallonia, the total production of RS&A can be estimated at 3.5 Mt in 2017 [10], with a total number of recycling plants probably close to one hundred, mainly located around the largest cities. Almost 14 Mt of certified RS&A were produced in Flanders in 2013. Between 200 and 250 recycling plants are identified in Flanders. Only a few C&DW recycling plants are localized in the Brussels-Capital region. Most of C&DW are exported to Wallonia or to Flanders for recycling [9].

Extractive industry represents between 160 and 200 extraction sites. The annual overall Belgian consumption of natural and RS&A is estimated at 100 Mt [11]. The annual production of natural sands and aggregates is estimated at 70-75 Mt. Every year, about 15 Mt of extracted natural materials are exported, and 20 Mt of natural materials are imported, mainly to/from neighbouring countries. Due to geological context, about 80% of the annual turnover of the Belgian extractive industry comes from the southern part of the country. As a result, the mean distance from quarries is 70 km in Flanders compared to 40 km in Wallonia.

2.2. France

The total amount of C&DW generated in France represented 241 Mt in 2012, including excavated unpolluted soils and stones that accounted for 175 Mt (70% among inert C&DW) [12]. Inert C&DW excluding excavated soils and stones reach about 60 to 70 Mt per year. Among inert C&DW, concrete accounts for 28%, bituminous mixtures represent 15%, other materials from roadways are estimated at 19% and mixed inert wastes account for 27% (data 2008, [13]).

According to the French Producers of Aggregates (UNPG – “Union Nationale des Producteurs de Granulats”), 25.7 Mt of recycled aggregates were produced in 2016 [14]. Among them, 21.4 Mt came from construction and demolition activities and 4.3 Mt were produced from industrial processes. The amount of RS&A from demolition represents about 6% of the total production of sands and aggregates (natural, manufactured and recycled). However, this data does not take into account inert materials that are recycled on-site. The quantity of sands and aggregates recycled on-site could be estimated at 40 to 50 Mt. It means that the total quantity of RS&A produced in France could be estimated around 65 to 75 Mt and corresponds to 15-20% of the total production of sands and aggregates [14]. About 400 C&DW recycling plants are inventoried in France by the UNPG.

Around 80 Mt of inert wastes (including excavated soils and stones) were landfilled in 2012. This represents 35% of the total amount of inert wastes produced in France. The country is covered by 657 landfills class 3 (for inert wastes, called ISDI for “Installations de Stockage de Déchets Inertes”) [14]. There is no banishment for landfilling inert C&DW in France. Furthermore, it is widely acknowledged that the current level of landfill tax, even if steadily increasing, is not high enough to be a sufficient deterrent [13].

In 2016, 304.4 Mt of natural sands and aggregates were extracted from about 2,300 pits and quarries. This represents a yearly production of 4.5 tons of natural sands and aggregates per inhabitant. The most productive regions are mostly located in the southern and western parts of the country. This distribution contrasts with the most productive area in RS&A: these regions are mostly located in the northern part of France where 50% of the production is concentrated [14]. The consumption of sands and aggregates by the French market reached 423 million tons in 2014 with 23.1% from recycling (on-site or in sorting-recycling plants) and 70-75% from natural origin [14]. About 9 Mt of sands and aggregates were exported and 10.7 Mt were imported in 2016, mainly to/from neighbouring countries.

2.3. Germany

In Germany, 202 Mt of C&DW were generated in 2014. This amount includes 118.5 Mt of excavated soils and stones. By excluding these materials, the resulting quantity of C&DW represented 83.5 Mt. The CBTC fraction represented between 60 and 65% of the C&DW (excl. soils and stones) [15].

The production of RS&A represented 67.6 Mt in 2014 [15]. Germany includes more than 2,000 C&DW treatment facilities. However, 30% of these are located in Bavaria which is the second most productive state for RS&A behind North Rhine-Westphalia. The total capacity of the recycling

facilities is estimated at 107 Mt per year. Most of the states have enough spare capacities left and some of them run with significant overcapacities (Brandenburg, North-Rhine Westphalia) [16].

About 800 landfills related to inert wastes are located all over the country. However, the total number of landfills has regularly decreased since 2005. Excluding excavated soils and stones, less than 5% (corresponding to 3-4 Mt) of the yearly generated C&DW have been landfilled since 2010 [16]. Landfill tax depends on the type of waste and varies from one state to another in Germany. An example reported in the western part of Baden-Württemberg applies landfill taxes of 14 EUR/t for recyclable C&DW [4].

Germany is the European largest producer of natural sands and aggregates with a production estimated at 475 Mt in 2016 [17]. Germany alone extracts more than 20% of the total sands and aggregates produced in the EU-28. The extractive industry represents approximately 3,200 extraction plants. According to MIRO (“Mineralische Rohstoffe” - German Aggregates Federation), the country has sufficient reserves of mineral raw materials and, particularly in terms of construction, does not need to import materials. The German annual demand of sands and aggregates is estimated at 500 Mt.

2.4. Luxembourg

Data from the Administration of the Environment in Luxembourg indicate that the total amount of inert C&DW represented 6.79 Mt in 2013. This amount can be subdivided into two categories: 6.26 Mt (92%) of soils and stones and 0.535 Mt (8%) generated from building construction and demolition. About 98% of this second category is recycled. The rest is landfilled [18]. Among inert C&DW, CBTC category is estimated at 50% (about 0.27 Mt) [19]. Concrete represented about 0.178 Mt in 2010 [20]. However, the amount of inert C&DW generated and recycled/recovered on-site is not known by the Administration and is not included into national statistics [21].

The production of RS&A was estimated at 1.8 Mt in 2010 [20]. This amount includes recycled soils, stones and other C&DW. About 0.65 Mt of inert wastes are also exported for recycling. The Administration of the Environment in Luxembourg inventoried 32 mobile crushers and 2 recycling plants for road inert wastes in 2012 [22].

Landfilling of inert waste is not banished in Luxembourg: 5.4 Mt of C&DW were landfilled in 2013. However this amount is mainly constituted by more than 95% of excavated soils and stones [18]. The territory is covered with 12 landfills for inert wastes in 2013 [23].

According to UEPG [17], there are 13 extraction sites for aggregates and sands production in Luxembourg. Around 1 Mt of natural sands and aggregates are produced annually.

2.5. The Netherlands

In the Netherlands, 23.8 Mt of C&DW were produced in 2014. This amount has been stabilized since 2000. The CBTC fraction accounted for 80-85 % (19-20 Mt) in 2014. About 11 Mt of concrete wastes are produced every year. This represents 55 to 60 % of the CBTC fraction [24].

The members of the national federation of C&DW recyclers (BRBS – “Recycling, Branchevereniging Brekenen Sorteren”) produce more than 75% (~18 Mt) of the total volume of C&DW generated in the country. Recycling facilities are subdivided in three categories: crushing recycling plants (35%), sorting recycling plants (20%) and crushing + sorting recycling plants (45%). These recycling plants are widely spread all over the country (more than 150 locations) even if closer to the main cities [25]. Most of the recycled materials come from the south-eastern part of the country (Gelderland and Limburg) [26].

According to a decree, inert C&DW in the Netherlands must be recovered and have been prohibited from landfilling since 1995.

The Dutch extractive activity is subdivided into a regular part and a non-regular one, which are both mainly related to backfilling and land elevation projects. The regular extraction of primary building materials corresponds to about 55 to 80 Mt (average 65 Mt) per year. Only 7% of the supply is made of coarse gravels mainly coming from Limburg (South-East). It is clear that the demand of coarse aggregates is much higher than the national production: 70% of the coarse aggregates are

imported from Germany, Belgium (Wallonia), Norway, Scotland and UK. These materials are transported on distances exceeding 100 km [26]. According to UEPG, primary raw materials for construction are extracted from approximately 300 quarries and extraction sites [17].

The total need for sands and aggregates is estimated at 85-110 Mt per year (excluding non-regular extraction activity). The demand of natural raw materials is higher than the supply at national scale. This makes favourable the national market of recycled aggregates. Recycled materials represent from 20 to 35% of the regularly extracted primary raw materials [4].

3. Discussions

In order to point out some drivers and barriers related to the market of RS&A in NW European countries, three main key parameters are developed in more details: inert C&DW landfilling, the challenge with primary raw materials and the availability of inert C&DW recycling plants. To promote recycling, C&DW landfilling needs to be limited or prohibited. This can be performed by a legislation limiting or prohibiting landfilling, or by landfill taxation. The market of RS&A is also heavily influenced by the availability and the quality of natural materials. The price of primary raw materials is largely influenced by transportation costs: the more locally the natural materials are produced, the higher the challenge for RS&A is. Furthermore, the type of recycling process has a major influence on the quality of the recycled products. Usually stationary facilities are able to produce RS&A with a higher quality than mobile recycling plants [27]. The density of recycling facilities is also a key issue in order to limit transportation costs, while extractive industry for primary raw materials is mainly constrained by the geological context. Table 2 summarizes the main investigated drivers and barriers for the market of RS&A related to the investigated countries.

The Belgian market of RS&A is very different from one region to another. The country has a regional legislation for waste management and recycling. The ban for inert C&DW landfilling in Flanders and in Wallonia certainly constitutes a major incentive for recycling. The market is more favourable in Flanders where the challenge with primary raw materials is lower than in Wallonia due to higher costs related to longer transportation distances. The C&DW recycling facilities are widely spread all over the country and the network of recycling plants is denser in Flanders, partially due to a higher density of population.

In France, inert C&DW recycling seems more developed in the northern regions, where 50% of the production is generated in the Ile-de-France, Grand Est and Hauts-de-France regions. These three regions are also responsible for the production of only 15% of massive rocks [14]: the challenge with primary raw materials is lower than in the other regions. In France, landfilling of inert wastes has been a prevalent outcome yet. The applied landfill taxes for these types of wastes are too low to systematically guide materials to recycling purposes. Furthermore, the available network of recycling facilities seems to be not dense enough to limit transportation costs.

Table 2. Drivers and barriers for the market of recycled sands and aggregates in NW European countries.

	Belgium	France	Germany	Luxembourg	Netherlands
Inert C&DW landfilling	Driver	Barrier	Driver	Driver	Driver
Challenge with primary raw materials	Driver (in Flanders) Barrier (in Wallonia)	Driver (in the North) Barrier (in the West and the South)	Barrier	Barrier	Driver
Available inert C&DW recycling plants	Driver	Barrier	Driver	Driver (density of facilities) Barrier (low quality of RS&A)	Driver

Inert C&DW are not banished for landfilling in Germany. However, the landfill taxes seem to be high enough to push the majority of C&DW to recycling. Less than 5% of inert C&DW (excl. excavated soils and stones) are yearly landfilled. Germany is the largest producer of primary raw materials in the EU-28. The challenge with natural materials is consequently high. However, the country is covered by a dense network of C&DW recycling plants limiting transportation costs.

In Luxembourg, there is no banishment for inert C&DW landfilling. However, less than 5% of inert materials (excl. excavated soils and stones) are landfilled every year. The challenge with natural materials is high due to importations from neighbouring regions. The large number of mobile plants available in the country constitutes an incentive for recycling. As mobile recycling facilities usually produce lower quality recycled materials, this situation fosters downcycling of recycled materials that are mainly used for road foundations.

The ban for inert C&DW landfilling has been applied for many years in the Netherlands. This is a major driver for recycling. Another main driver is constituted by low challenge with primary raw materials, mainly with hard rocks. Indeed, 70% of coarse aggregates are imported, increasing transportation costs for these materials. The market for RS&A is thus propitious in the Netherlands. This is promoted by a dense network of C&DW recycling facilities located all over the country.

4. Conclusions

Understanding the market of recycled sands and aggregates (RS&A) needs to take into account many different parameters, some of them being difficult to assess. Through a quantitative analysis, this study evaluates some of the main drivers and barriers related to the market of RS&A in NW Europe. The quantitative analysis consists in a collection of national and regional statistics on key parameters such as the amount of generated C&DW, the production of natural and RS&A, the density of recycling plants, the density of extraction sites for natural materials. These data are also combined with national and regional legislation on C&DW landfilling.

Results point out that the market of RS&A is more developed and more suitable in the Netherlands and in Flanders (North of Belgium) where all the investigated parameters are considered as drivers. These regions are characterized by a lack of available local natural rocky materials, a developed framework of recycling plants for inert C&DW and a favourable legislation that push the waste flux to sorting and recycling. The market in Wallonia (South of Belgium), France, Germany and Luxembourg is challenged by primary raw materials where resources are locally abundant. The French market of recycled materials is furthermore disadvantaged by a lack of incentives that foster sorting and recycling.

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