WP T1 - Activity 1 - Material flow / Territorial analysis

Deliverable 1.1 Sand resources in NWE

Julien HUBERT, Frédéric MICHEL, Luc COURARD

University of Liège, Belgium

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INTRODUCTION

This report aims to investigate aggregate and sand production within the European Union, focusing on the NWE (North-West Europe) region.

In the initial phase of our analysis, we will assess aggregate production, encompassing both natural and recycled sources, at the EU27+UK level. Subsequently, we will gather and present data specific to each partner country (in separate documents). This report will begin with an examination of natural sand and aggregate deposits, followed by an exploration of Construction and Demolition Waste (C&DW) production and its composition. Finally, we will delve into the production of recycled sands and aggregates. Furthermore, wherever available, we will examine the flows of natural and recycled materials. These flow patterns will help identify countries or regions facing shortages of natural resources that could potentially be met by utilizing recycled materials. This information will shed light on the burgeoning market for recycled aggregates and sands.

SANDS AND AGGREGATES PRODUCTION AT THE EUROPEAN SCALE

Aggregate and sand materials are in high demand globally for construction purposes, with an annual growth rate of around 5% while the availability of sand is decreasing. Figure 1 shows the clear increase in sand demands over the previous and coming years. The United States and China show overall the highest yearly demand of sand.

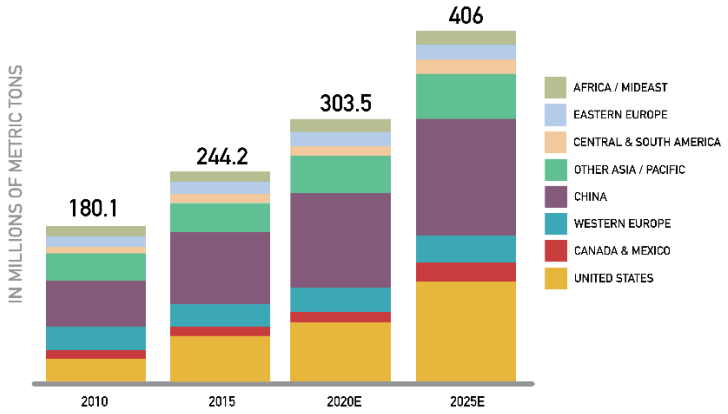


Figure 1. World sand demands in millions of metric tonnes.
https://iveybusinessreview.ca/6580/lafargeholcim-the-plastic-solution-to-the-global-sand-wars/graphic-2-world-sand-demand/

The global consumption of construction aggregates is expected to reach 62.9 billion metric tons by the end of 2024, up from 43.3 billion metric tons in 2016 (Julia K. Steinberger,2021). Within Europe, EU27+UK+EFTA aggregate demand reached 2.7 billion tons annually in 2015, generating an estimated annual turnover of €15 billion. This European (EU27+UK+EFTA) demand represents approximately 10% of the global demand for aggregates, equating to 6 tons per capita per year (UEPG, 2021).

Figure 2 provides a synopsis of the 2019 national production tonnages categorized by country and aggregate type. Germany emerged as the leading producer, surpassing 500 million tons, followed by Russia, Turkey, France, the UK, and Poland. In contrast, smaller nations such as Malta, Montenegro, Iceland, Luxembourg, and Cyprus exhibited production levels below 5 million tons. National tonnages depend not only on economic strength, but also on geological availability of and access to deposits, national ambient climate, ruggedness of the terrain and local building traditions.

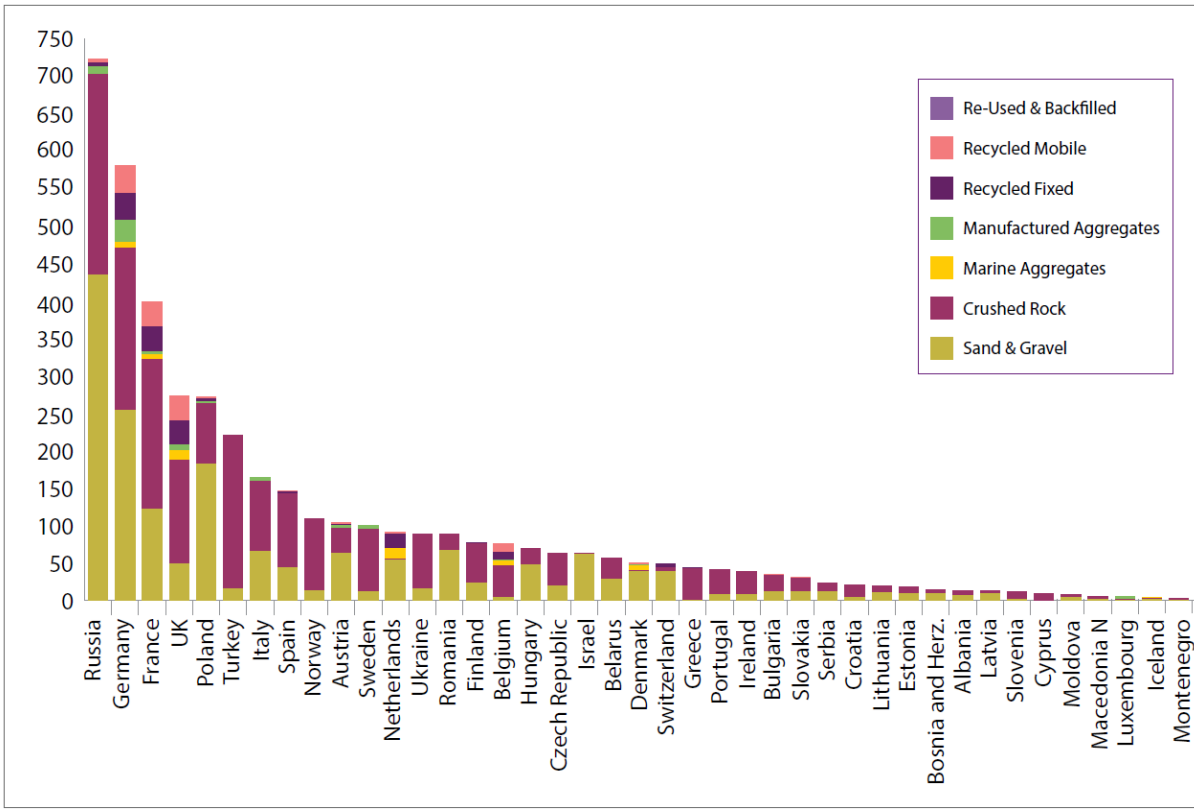


Figure 2: 2019 aggregates production in Europe (UEPG, 2021)

Figure 3 : Aggregates types percentages

The composition of aggregate types in the EU27+UK+EFTA countries in 2019 revealed that crushed stone accounted for 46.9% of all production, while sand and gravel constituted 39.7%. Aggregate production from recycled and reused materials contributed 9.3%, with marine and manufactured aggregates comprising the remaining 4%.

Figure 4 delineates production trends from 2006 to 2020 within the EU27+UK+EFTA countries. After seven years of decline from 2007 to 2013, production went back up and stabilized around 3 billion metric tons until the Covid 19 pandemic affected production.

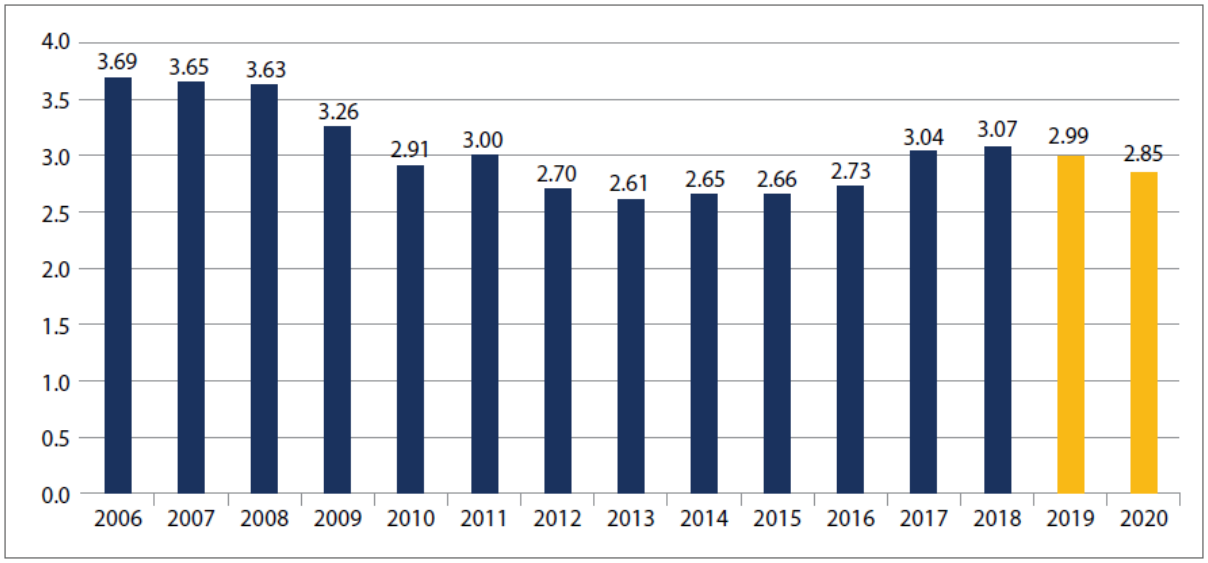


Figure 4: EU+UK+EFTA Trend in Production in Billions of Total Tons (UEPG, 2021)

The global sand market is constantly affected by unbalances in import and export over the world. Figure 5 shows the top 10 of countries with the highest export in fine aggregates between 2010 and 2014.

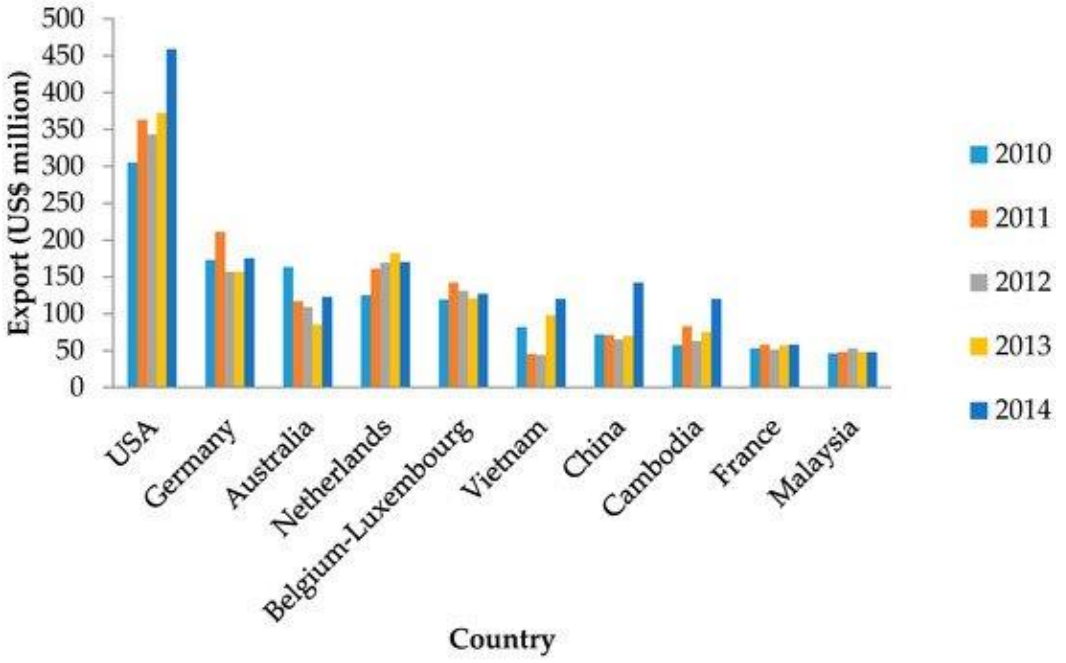


Figure 5: Top 10 of sand exporting countries over the world between 2010 and 2014 (Dan Gavriletea, 2017)

Table 1 provides a detailed breakdown of aggregate production in various European countries, including the number of producers, extraction sites, and production volumes categorized by aggregate type.

Table 1: estimates of aggregates production (UEPG, 2021)

	Total Number of Producers (Companies)	Total Number of Extraction Sites (Quarries and Pits)	Sand & Gravel (millions tonnes)	Crushed Rock (millions tonnes)	Marine Aggregates (millions tonnes)	Manufactured Aggregates (millions tonnes)	Recycled Aggregates (millions tonnes)	Total Production (millions tonnes)
Albania	205	205	7.0	5.5	0.0	0.0	0.0	13
Austria	1069	1363	63.0	33.0	0.0	3.0	4.0	103
Belarus	100	80	28.8	26.5	0.0	0.0	0.0	55
Belgium	84	117	5.0	40.0	7.0	1.0	22.0	75
Bosnia-Herzegovina	15	30	10.0	4.0	0.0	0.0	0.0	14
Bulgaria	217	295	12.1	21.2	0.0	0.0	1.0	34
Croatia	138	225	4.5	14.9	0.0	0.0	0.0	19
Cyprus	24	24	0.0	8.4	0.0	0.0	0.5	9
Czech Rep	168	380	20.0	42.0	0.0	0.0	0.0	62
Denmark	142	372	38.8	0.5	6.6	0.5	3.0	49
Estonia	170	290	10.0	7.8	0.0	0.0	0.0	18
Finland	1500	2140	23.8	51.0	0.0	0.0	2.0	77
France	1735	3012	122	199	6.5	4.0	67.0	399
Germany	1338	2691	255	215	8.0	30.0	72.0	580
Greece	109	198	0.2	42.0	0.0	0.0	1.0	43
Hungary	399	540	48.0	21.0	0.0	0.0	0.0	69
Iceland	28	56	1.8	0.5	0.4	0.0	0.0	3
Israel	18	30	62.0	0.0	0.0	0.0	0.0	62
Ireland	104	430	8.0	30.0	0.0	0.0	0.0	38
Italy	1120	2800	66.0	92.0	0.0	6.0	0.0	164
Latvia	55	105	9.2	2.5	0.0	0.0	0.0	12
Lithuania	70	220	11.4	7.3	0.0	0.0	0.0	19
Luxembourg	7	13	0.2	1.0	0.0	3.0	0.0	4
Macedonia (North)	8	20	2.0	3.0	0.0	0.0	0.0	5
Malta	5	10	0.4	1.0	0.0	0.0	0.4	2
Moldova	30	130	5.0	2.0	0.0	0.0	0.0	7
Montenegro	28	36	0.5	2.0	0.0	0.0	0.0	3
Netherlands	237	280	54.1	0.0	14.5	0.0	22.5	91
Norway	793	1023	13.9	94.4	0.0	0.0	0.5	109
Poland	1547	2816	183	79.0	1.0	2.0	7.0	272
Portugal	242	242	8.9	32.0	0.0	0.0	0.2	41
Romania	995	1090	67.5	19.8	0.0	0.0	0.0	87
Russia	1181	1485	435	268	0.0	10.0	10.0	725
Serbia	20	65	12.5	10.5	0.0	0.0	0.0	23
Slovakia	173	246	12.2	16.2	0.0	0.1	1.2	30
Slovenia	97	146	1.4	9.6	0.0	0.0	0.0	11
Spain	1056	1848	44.6	96.8	0.0	1.0	3.5	146
Sweden	704	1391	12.0	81.8	0.0	5.2	1.0	100
Switzerland	530	535	38.7	4.8	0.0	0.0	4.6	48
Turkey	1055	1165	15.9	204	0.1	0.0	0.0	220
Ukraine	140	140	16.0	72.0	0.0	0.0	0.0	88
UK	588	1301	49.8	137	13.4	7.4	64.9	272
42 Countries	18244	29585	1781	1998	58	73	288	4198
EU-28 + EFTA	15444	26199	1186	1401	57	63	278	2986
EU-28 only	14093	24585	1132	1301	57	63	273	2826

Recycling initiatives in the European aggregates industry exhibit notable variation across countries. Five EU nations – Belgium, UK, the Netherlands, Germany, and France - spearhead the production of recycled aggregates, contributing to around 90% of all recycled aggregates within the EU. This production substantially reduces the demand for primary aggregates, fostering sustainability (Deloitte, 2016).

The CIRMAP project partners' countries are therefore responsible for most of the recycled aggregates production, demonstrating the relevance of the consortium. Table 2 shows an

evaluation of the percentage of recycled aggregates vs total production of aggregates for the considered countries.

Table 2: estimates of recycled aggregates production (UEPG, 2017; data 2015)

	Total production (millions of tons)	**Recycled aggregates (RA) production (millions of tons)**	**Percentage of RA vs total production (%)**
Belgium	75	22	29.3
France	399	67	16.8
Germany	580	72	12.4
Netherlands	91	22.5	24.7
U.K.	272	64.9	23.9
EU28	**2986**	**278**	**9.3**

ANALYSIS FOR EACH NWE COUNTRY

The analysis combines information from national statistics, literature reviews, and reports, with inspiration drawn from Deloitte's work in 2016. The report scrutinizes the economic dynamics and the availability of materials in these markets, with particular attention to recycled aggregates.

The analysis centers on two key aspects within the sands and aggregates markets. Firstly, it explores the costs and benefits associated with recycled inert CDW from construction and demolition sites, emphasizing the recovery of recycled products. Secondly, it delves into the quantities of materials available in the market, considering the competition between recycled materials and primary raw materials like natural sands and aggregates. The report is structured as follows:

Each country's analysis is subdivided into the following sections:

- Data on the Construction Sector: This section presents general data on the construction sector, including turnover, employment, gross added value, and the number of construction and renovation projects. It also includes data on the quantity of concrete produced at the national level, distinguishing between Concrete Products Plants (CPPs) and ready-mixed concrete production.
- Production of Wastes: This section focuses on the annual amount of waste produced in each country, with a specific focus on inert CDW and CBTC (concrete, bricks, tiles, and ceramics). It also mentions the quantities of soils and stones produced, depending on national statistics.
- Production of Recycled Sands and Aggregates: Here, we examine the quantity of recycled sands and aggregates produced, the number of CDW recycling plants, the types of recycling plants, and the entrance and selling prices of inert CDW in recycling facilities.
- Landfilling: This section explores regulations governing landfilling of inert CDW, the number of existing landfills for inert wastes, and any taxes applied to landfill inert CDW.

- Extractive Industry: This subsection is critical, as recycled products compete with primary raw materials. It focuses on the quantity of natural sands and aggregates produced, the number of pits and quarries in the country, selling prices of natural materials, the location of pits and quarries, and the national consumption of sands and aggregates.

I.1 Belgium

Construction sector data

Table 3 details the employment respectively in mining and quarrying, and in construction sectors between 2017 and 2021 in Belgium.

Table 3: Employment (in thousands of persons) in Belgium[1].

	2017	2018	2019	2020	2021
Total	4830.3	4901	4978.9	4980.8	5071
Mining and quarrying	2.5	2.6	2.6	2.5	2.5
Construction	276.6	283.4	286.6	291.2	299.1

Table 4 points out general data concerning the number of new constructions and renovations between 2018 and 2022 in Belgium.

Table 4: Number of new constructions and renovated buildings in Belgium[2].

	2017	2018	2019	2020	2021
New construction					
Number of residential buildings	22759	28842	27486	28612	31755
Number of non-residential buildings	4084	5567	6501	6379	6597
Refurbishment					
Number of transformations in residential buildings	24313	28303	27935	29441	34237
Number of transformations in non-residential buildings	4108	4059	3692	3546	3869

Table 5 indicates data on turnover respectively of mining and quarrying sector and of construction sector between 2014 and 2016, in Belgium.

[1] https://stat.nbb.be/?lang=en&SubSessionId=9ee29afa-9fec-40ca-9e1d-b3d838dddd30&themetreeid=-200#

[2] https://statbel.fgov.be/fr/themes/construction-logement/permis-de-batir#panel-11

Table 5: Turnover (amounts in M€) in Belgium[3].

	2017	2018	2019	2020	2021
Mining and quarrying	0.90	1.08	0.95	1.05	1.48
Construction	67.84	71.76	77.66	75.76	84.51

FEBE is the Belgian federation of the prefabricated concrete industry. FEBE's members represent 85 % of the turnover of the sector in Belgium. The sector of prefabricated concrete represents yearly about 12 million tons of concrete, made by 255 companies, 6,800 employees, for a global turnover of 1 billion euros (FEBE).

FEDBETON, the Belgian Ready-Mixed Concrete Federation, represents companies in the concrete production, transport and pumping industry. The ready-mixed concrete sector brings some 270 concrete plants at a national scale for nearly 160 companies. It annually produces some 12 million cubic meters of concrete, or 1.13 m^3 of ready-mixed concrete per inhabitant and consumes more than 55% of the Belgian cement put on the market. It directly occupies nearly 4000 people. More than 2200 mixer trucks and nearly 300 concrete pumps deliver the 215,000 construction workers every day and implement ready-mix concrete in Belgium (FEDBETON, 2018, http://www.fedbeton.be/).

Production of wastes

In 2018, Belgium generated a total waste production of 67.5 million tons, including 22.5 million tons of construction and demolition waste. These waste materials consist of inert materials (such as concrete, bricks, ceramics, and tiles), non-hazardous waste (like paper, wood, plastics, and metals), hazardous waste (including solvents and asbestos), and excavated soil. The production of inert construction and demolition waste amounted to 18.5 million tons, making up slightly over 27% of Belgium's total waste production and over 82% of construction and demolition waste production. Belgium is recognized as one of the leading European countries in recycling inert construction and demolition waste, achieving a recycling rate of over 90% (Vrijders et al., 2019).

<u>Wallonia</u>

In addition to the estimated 10 million tons of soil, it can be approximated that between 5 to 7 million tons of inert C&DW waste are generated each year (Table 8) (Wallonia Waste Resource Plan, 2018).

[3] https://bestat.statbel.fgov.be/bestat/crosstable.xhtml?datasource=095cb5e3-a398-4372-8f30-3f9d96b3abd7

Table 6: Estimation of CDW produced in Wallonia (data for 2013, Plan wallon des déchets-ressources, 2018).

Types	Tonnages (millions de tonnes)
Déchets inertes (béton, briques, tuiles, carrelages, mortier, ciment, verre plat…)	Entre 5 143 et 6 972
Déchets non dangereux (papiers, cartons, plastiques, métaux, EPS, bois…)	0,8
Déchets dangereux (amianterésidus et emballages de peinture, solvant)	Pour mémoire
Terres excavées	10
TOTAL	entre 15,9 et 17,8

Composition of CDW is graphically represented in Figure 4.

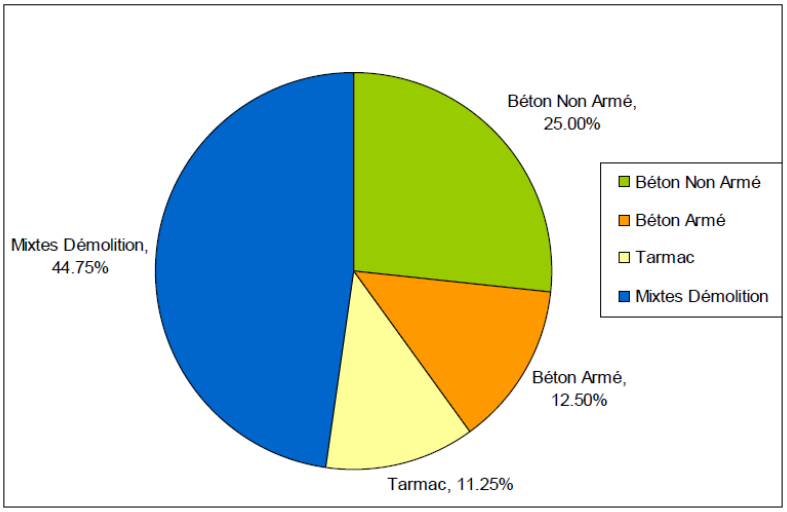


Figure 4. Composition of inert CDW from Wallonia (data for 2010; Plan wallon des Déchets Hoizon 2010).

Flanders

In 2014, in Flanders, approximately 15 million tons of construction and demolition waste were generated (OVAM, 2016). The composition of the waste is quite similar to that of Wallonia's waste and is illustrated in Figure 5. Approximately 95% of inert construction and demolition waste produced in Flanders are recycled (Emis).

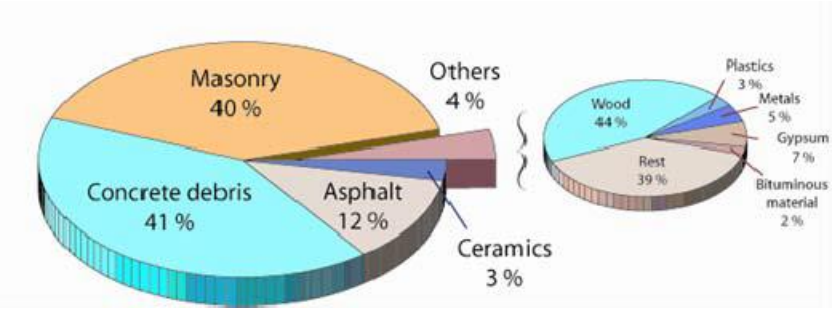


Figure 5: Composition of C&DW in Flanders (OVAM, data 2005).

Brussels-Capital Region

In Brussels, the quantity of generated waste was estimated to be between 600,000 to 700,000 tons in 2017 (Brussels Environment, 2018; Bernair et al., 2018). According to this study, 91 % of the produced wastes are recycled. The percentages of the different types of C&DW is visible in Table 7. Inert CDW accounted for about 75 % of the total weight for C&DW produced in Brussels-Capital Region in 2015 and the subcategories accounted for in the inert C&DW are presented in Figure 6.

Table 7: Flux of materials coming from construction/demolition sector in 2015, expressed in tons (Bernair et al., 2018).

	ENTRANTS		SORTANTS	
	(tonnes)	%	(tonnes)	%
INERTES	652.459	74%	453.547	72%
METAUX	86.313	10%	65.940	10%
BOIS	57.619	7%	45.636	7%
PLATRE	40.330	5%	31.917	5%
PLASTIQUE	19.296	2%	14.581	2%
ISOLATION	27.365	3%	21.721	3%
AUTRES	522		341	
TOTAL	**883.904**		**633.683**	

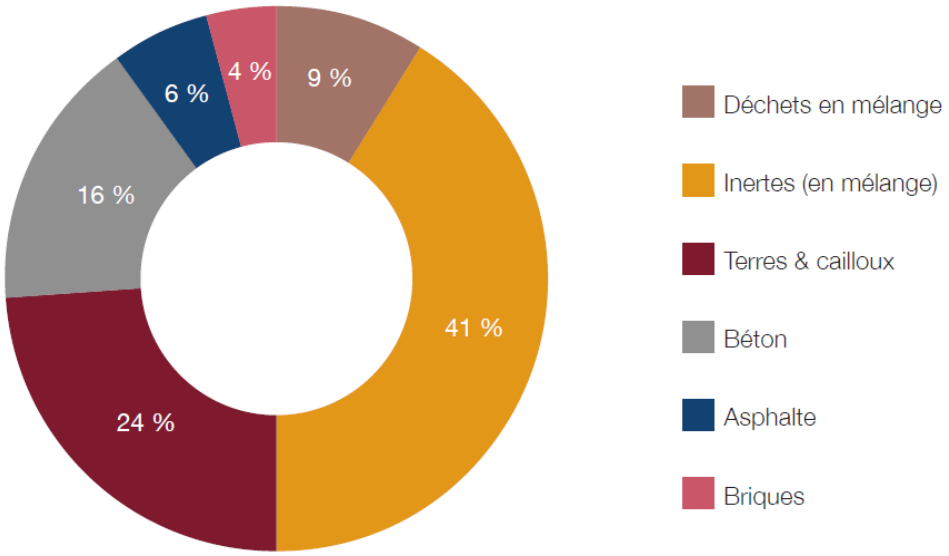


Figure 6: Composition of inert C&DW in Brussels-Capital region in 2014 (Bernair et al., 2018).

Production of recycled aggregates and sands

In 2019, the total production of aggregates in Belgium was estimated to be 75 million tons, including 22 million tons of recycled aggregates, accounting for nearly 30%. This positions Belgium as the top performer in terms of relative production of recycled aggregates, surpassing the United Kingdom (27%) and the Netherlands (25%) (UEPG, 2021).

Belgium has a little over 350 recycling centers: 80% of them are fixed installations, while the remaining 20% are mobile facilities. Among these 350 installations, 288 are certified by COPRO and are distributed as shown in Figure 7 (COPRO, 2020).

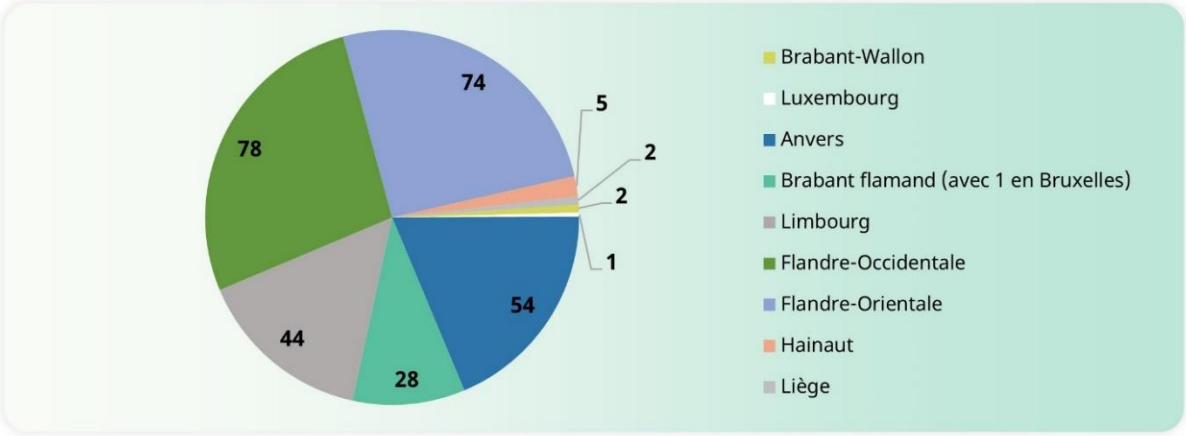


Figure 7: Geographic repartition of the Belgian recycled aggregates production centers (COPRO, 2020).

This number has seen a slight decrease since 2019, partly due to the COVID-19 pandemic. Additionally, 39 more facilities are certified by CERTIPRO (CERTIPRO, 2018), and 28 by Be-Cert (Be-Cert, 2018).

<u>Wallonia</u>

In 2018, Wallonia had 258 authorized centers for sorting and recycling inert construction and demolition waste. Most of these centers are located north of the Sambre and Meuse Valley, particularly in the Liège and Charleroi regions (Figure 8). The annual production of recycled aggregates in Wallonia is estimated at 4 million tons.

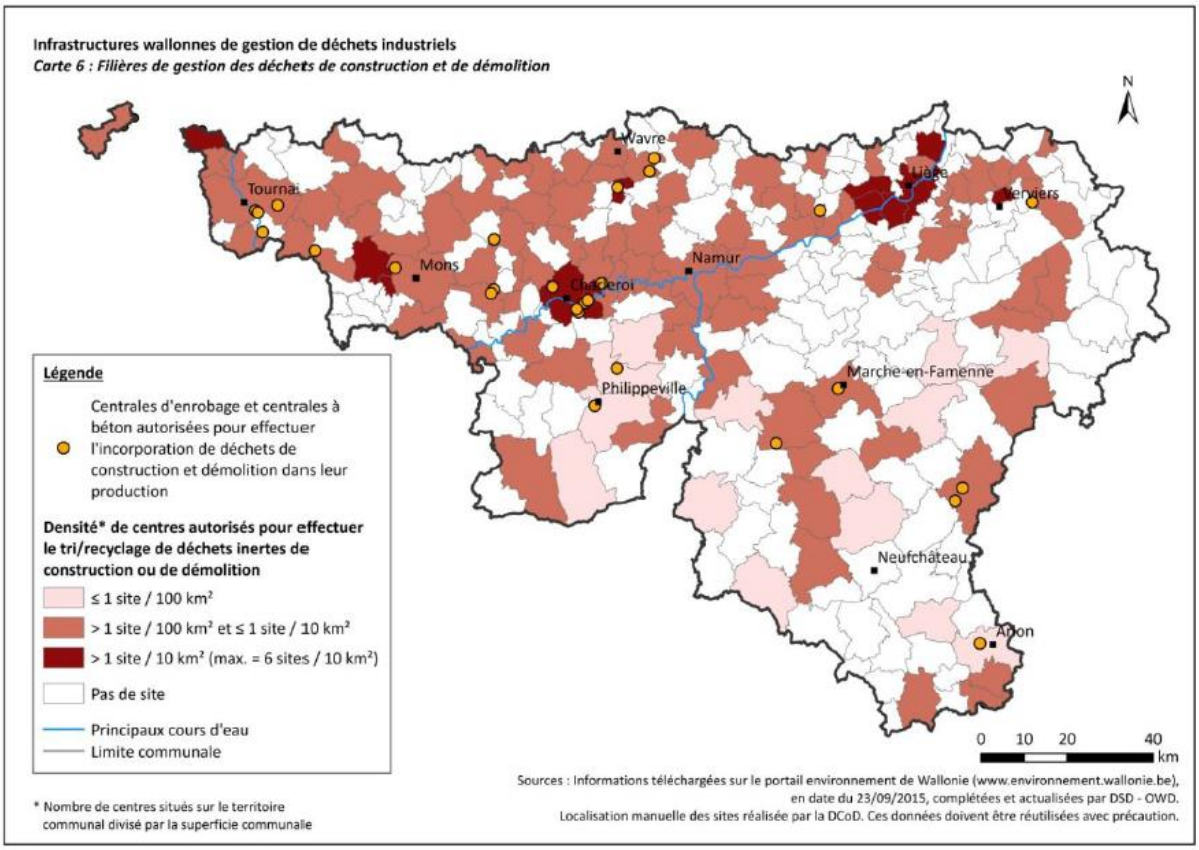


Figure 8: Geographic repartition of the Walloon C&DW treatment centers (Plan Wallon Déchets Ressources, 2018).

Furthermore, Wallonia is home to a federation of recycled aggregate producers called FEDERECO ("Professional Federation of Construction Waste Recyclers and Recycled Aggregate Producers in Wallonia"), which plays a crucial role in promoting the use of recycled products to the Wallonian public authorities (FEREDECO, 2018). This federation comprises 42 members representing 51 recycling centers spread across the entire region (Mariage, 2018) (Figure 9). These centers are responsible for the storage, sorting, and crushing of inert construction and demolition waste, producing a wide range of recycled aggregates in accordance with the NBN EN 13242 standard and regional recommendations (QUALIROUTES 2018). In 2017, the production of FEDERECO members amounted to approximately 2 million tons.

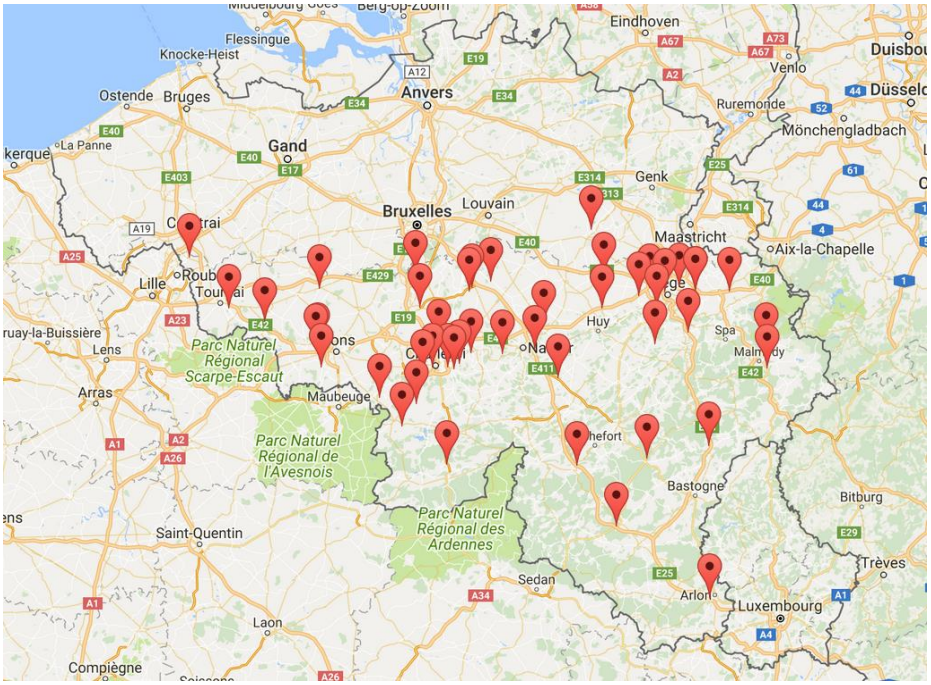


Figure 9: Geographic repartition of the FEREDECO members (http://www.feredeco.be/).

Flanders

The quantity of certified recycled aggregates in Flanders increased from 2 million tons in 1992 to 15 million tons in 2018 (FRPG, 2019). FRPG ("Federatie van Producenten van Recycling Granulaten") represents recycled aggregate producers in Flanders, and the geographic distribution of its members can be seen in Figure 10.

Figure 10: Geographic repartition of the Flemish recycled aggregates production centers (http://www.fprg.be).

Between 200 and 250 recycling centers operate in Flanders (with 219 aggregate producers listed on the Tracimat online portal). Moreover, in Flanders, the non-profit organization Tracimat was established to act as a catalyst for the circular economy. Its mission is to inventory materials discarded during the demolition or renovation of infrastructure or structures to reduce downcycling. This inventory aims to better estimate the material flows (where and when) and provide improved traceability of materials, ensuring they are not contaminated by hazardous substances or difficult-to-recycle materials. The assurance of high-quality recycled material through Tracimat certification serves as an incentive for using recycled aggregates in higher value-added applications.

Brussels-Capital region

A few CDW recycling plants are localized in the Brussels-Capital region. Most of CDW are exported in Wallonia or in Flanders to be recycled as can be seen in Table 7 withon which an incoming flow of inert C&DW of 652.459 tons and a practically equivalent outgoing flow of 453.547 tons.

Landfilling

Wallonia

The Decree of the Walloon Government of 18 March 2004[4] gives criteria for the admission of wastes in landfills. According to the decree inert CDW cannot have been placed in landfills since 1st January 2006. As a result recycling of CDW has become an obligation since 1st January 2006. Excavated soils are not covered by this decree.

Flanders

In Flanders, it has been prohibited to landfill the following wastes since 2005:

- Unsorted household and industrial wastes
- Waste collected selectively for the purpose of recovery
- Waste that can be recovered according to its nature, quantity and homogeneity
- Medical waste that is old and expired

Thus, CBTC wastes are ban for landfilling in Flanders since they can be recovered.

Brussels-Capital region

No landfill exists in the Brussels-Capital region. CDW coming from the Brussels-Capital region are governed by the legislation of the region where they are recycled.

Extractive industry

The extractive industry plays a vital role in Belgium's industrial and economic activities. This sector is responsible for creating over 4,000 direct local jobs and 8,000 indirect jobs. It encompasses between 160 and 200 extraction sites and generates an annual turnover of €750 million within Belgium.

In Belgium, the extractive industry is represented by Fediex, a Federation of the extractive industry and non-combustible rock transformers. Fediex brings together more than 50 companies engaged in the production of aggregates (including limestones, hard rocks,

[4] 18 March 2004 – Arrêté du Gouvernement wallon interdisant la mise en centre d'enfouissement technique de certains déchets - http://environnement.wallonie.be/legis/dechets/decen008.htm

alluvial materials, and marine aggregates), industrial sand, lime, dolomite, and ornamental rocks. Fediex accounts for 85% of the total extracted tonnage in Belgium (Fediex, 2018, http://www.fediex.be/).

The annual consumption of natural sand and aggregates in Belgium is estimated at 90 million tons. The annual production of natural sand and aggregates is estimated to be in the range of 70-75 million tons. Approximately 15 million tons of extracted materials are exported from Belgium each year, primarily to neighboring countries (Figure 11) (Fediex, 2018, http://www.fediex.be/).

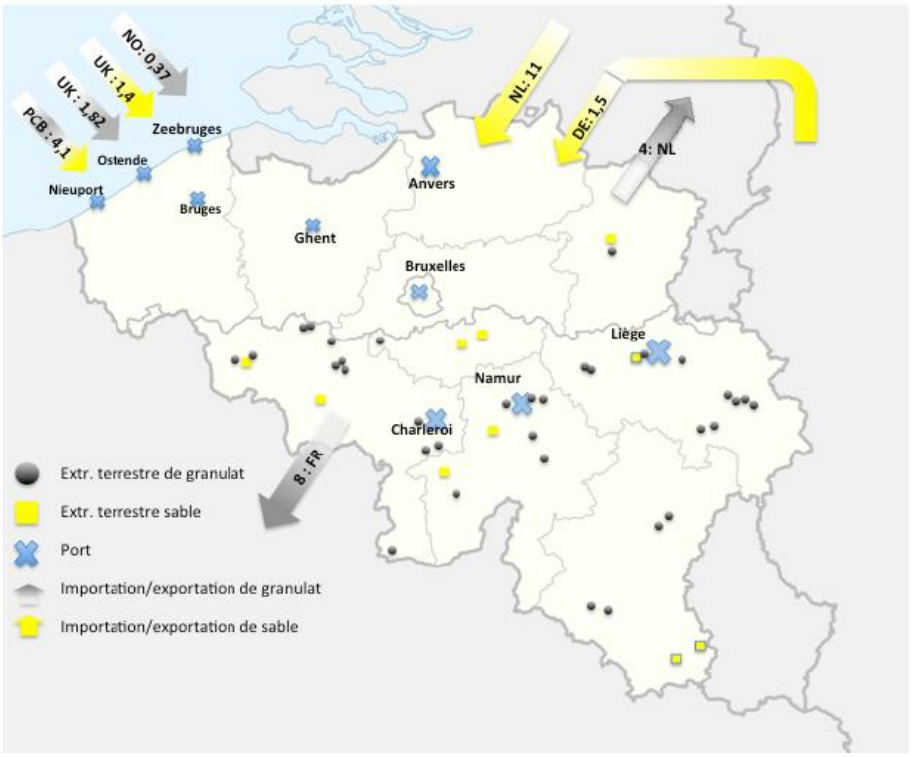


Figure 11: Imports and exports of natural sand and aggregates in/from Belgium (Adant & Chevalier, 2014).

Sands and aggregates represent 85 % of the transported materials for the extractive industry in Belgium (Fediex, 2018, http://www.fediex.be/). A study on the transportation of goods in Europe concluded that: "*The distribution of road freight transport activity by distance class reveals that more than half (55%) of all goods in terms of their weight are not transported more than 50 km. Three quarter of all goods are not transported more than 150 km. It is in these distance brackets where road transport has no economically viable competing mode of transport. Only around a quarter of all goods are transported over distances greater than 150km*" (European Commission, 2010).

Table 8 mentions mean consumption of all type of sand and aggregates (recycled and natural) and mean distances of transportation of extracted materials, for each province of Belgium. It clearly appears that the mean distance is higher for provinces located in Flanders than for provinces located in Wallonia.

Table 8. Estimation of the consumption of sand and aggregates (natural and recycled) and mean distance of transportation from quarries, for each Belgian province (Adant & Chevalier, 2014).

Provinces and Brussels	**Consumption (Million tonnes)**	**Mean distance from quarry (km)**
Antwerp	13.78	102
Flemish Brabant	8.51	70
Walloon Brabant	9.16	42
Brussels	11.32	56
West Flanders	6.62	39
East Flanders	27.64	70
Hainaut	3.00	40
Limburg	10.35	64
Liege	8.43	43
Luxembourg	0.59	38
Namur	2.13	45

Wallonia

The majority of the extraction sites are located in Wallonia (Figure 12). About 80 % of the annual turnover of the Belgian extractive industry comes from Wallonia (Fediex, 2018, http://www.fediex.be/).

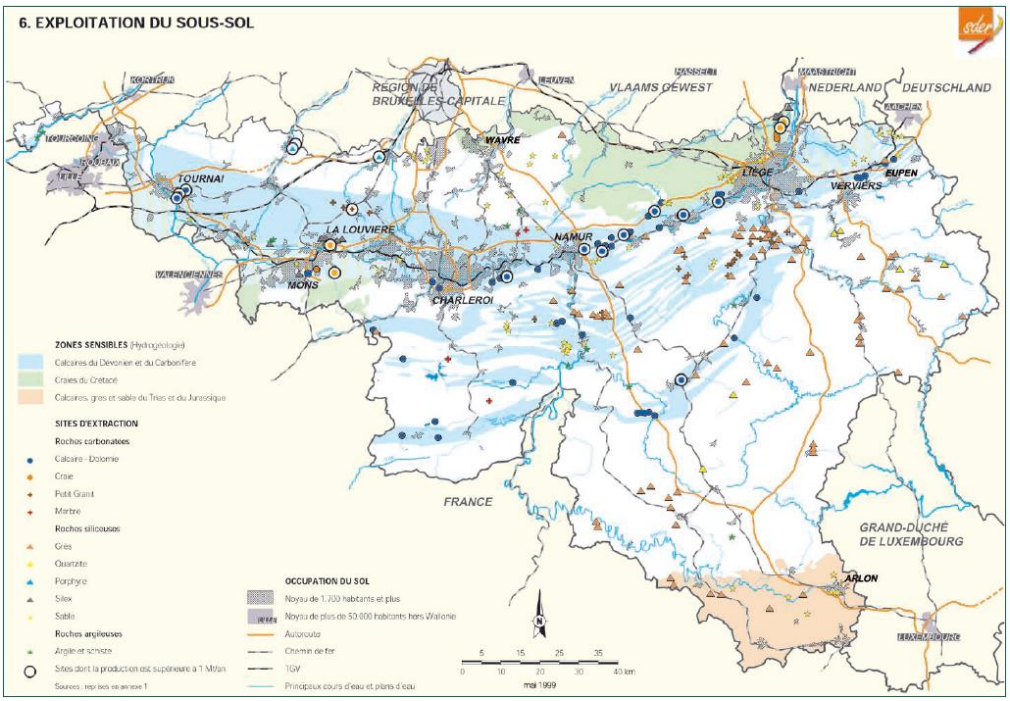


Figure 12: Location of quarries in Wallonia (DGARNE, 2010).

Table 9 shows estimated mean prices (incl. VAT) for the main primary products on the Belgian market.

Table 9. Estimated mean prices (VAT included) for natural sands and aggregates on the Belgian market.

Materials	**Estimated mean prices (VAT included) (in €/t)**
Sands	
Rhine sand 0/4	6-10
Crushed limestone 0/4	6-7
Limestone aggregates	
Specific grain sizes (i.e. 2/4, 6/14, 20/32)	10-14
Non-specific grain sizes (i.e. 0/6, 0/14, 0/32)	7-10
Sandstone aggregates	
Specific grain sizes (i.e. 2/4, 6/14, 20/32)	14-18
Non-specific grain sizes (i.e. 0/6, 0/14, 0/32)	9-13

Conclusion

The total consumption of sands and aggregates (recycled + natural) in the country is about 100-105 million tons. Of this, the total production of aggregates amounts to 70-75 million tons (covering 70% of the demand), and the total production of recycled sands and aggregates stands at 22 million tons (22% of the demand). Presently, Belgium exports 15 million tons of natural sands and aggregates while importing about 20 million tons, indicating that the Belgian aggregates and sands market is not saturated. However, the challenge with natural materials remains significant.

Most recycled aggregates in Belgium are downcycled since they are primarily used in base and sub-base layers of roads. The market for recycled aggregates and sands can vary significantly from one region to another in Belgium depending mostly on the availability of natural aggregates.

Around 80% of the natural aggregates produced in Belgium come from Wallonia, which poses a challenge when comparing recycled aggregates and sands with natural materials. On the other hand, recycled aggregates account for 25-30% of the total production in the country, roughly equivalent to Wallonia's aggregate consumption (23%). Wallonia boasts about 100 recycling plants, with a relatively high density of one recycling plant every 200 km^2, especially near major urbanized areas like Charleroi, Mons, Liège, and Namur. The ban on landfilling inert CDW (excluding soil) since 2006 has been a significant incentive

for CDW recycling in this region. However, certain recycled products, particularly finer fractions, face challenges due to factors like competition with natural products, limited allowed applications as per public specifications, stringent criteria that recycled materials must meet for use in public works, and issues related to traceability and quality assurance of recycled products. Nevertheless, the region is increasingly embracing the concepts of the circular economy, which may bring about changes in the near future.

In Flanders, the CDW recycling industry is well-developed, boasting over 200-250 recycling plants, translating to a density of 1-2 recycling plants every 100 km^2. Flanders achieves a recycling rate of over 90% for CDW, and the region contributes to 75-80% of the total recycled aggregate production in the country. Flanders also consumes 65-70% of the total Belgian aggregate production. Since natural sands and aggregates primarily come from Wallonia or neighboring countries, the mean distance from quarries is longer in Flanders (70 km) compared to Wallonia (40 km). This significant distance acts as a key economic incentive to promote CDW recycling in Flanders. Additionally, regulations banning the landfilling of most inert CDW, more flexible public specifications allowing a wider range of applications for recycled products, and enhanced traceability and quality assurance measures further boost CDW recycling in Flanders.

The Brussels-Capital region generates less than 5% of the CDW produced in Belgium, with most of these waste materials being recycled outside the region, primarily in Wallonia or Flanders. Public specifications for recovering recycled CDW in the Brussels-Capital region closely align with those of Wallonia and Flanders. Furthermore, the region lacks quarries for natural aggregates extraction, resulting in an average quarry distance of 55 km. Therefore, CDW recycling from plants located in close proximity to the region could be economically favorable.

Table 10 (Flemish Region), Table 11 (Brussels Capital Region), and Table 12 (Walloon Region) illustrate the drivers and barriers needed to increase CDW recycling in Belgium.

Table 10: Drivers and barriers to increase CDW recycling in Flemish Region (Deloitte, 2015)

Flemish Region		
Factor / characteristic / element in CDW recycling chain	**Drivers**	**Barriers**
Legislation	- The adoption of several sectorial implementation plans for CDW management; - The technical framework allowing the use of recycled aggregates in the building of roads (Standaardbestek 250); - Taxes on landfilling.	- Differences in legislation among the Belgian regions
Treatment facilities	- Several treatment facilities for different CDW streams exist or are under development	
Standards		- Insurers might require certain technical standards for materials (such as BENOR standards) which are not always applicable to recycled aggregates.

Design and materials	- The use of natural products could facilitate the recycling (e.g. natural insulation), because it might have a less complex composition, which is easier to separate and recycle.	- Modern construction materials have a more complex structure (composite nature of construction materials) and different components are glued together. These wastes are more difficult to recycle and might end up in a landfill…
		- Logistical aspects related to the recycling of smaller streams might complicate the recycling
		- Challenges related to Insulation materials:
		  - Enough volume to recycle?
		  - Is transportation worth it (just transporting « air »)?
		  - Technical challenge
		  - Economically expensive to recycle (who will pay?)

Key stakeholder involvement	- The combination of stimulating both practical and technical solutions (use of aggregates in road construction) with economic benefits (landfill taxes) drove the stony-fraction recycling rate at 95% in Flanders.	

Table 11. Drivers and barriers to increase CDW recycling in Brussels Capital Region (Deloitte, 2015)

Brussels Capital Region		
Factor / characteristic / element in CDW recycling chain	**Drivers**	**Barriers**
Economy	- The cost of treatment for sorted waste is less expensive than for mixed waste (treatment cost of mixed waste is 3 to 10 times more expensive).	- The Joint Committee for the workers of the building is quite high, implying relatively expensive labor cost. This makes spending time sorting the waste too expensive. - the containers take up space on construction sites and are expensive - In Flanders, legislation is different. To send inert waste from Brussels in recycling facilities in Flanders, contractors have to prove that there is no hazardous waste in the inert waste. To prove it, contractors have to pay a lab test which is expensive. - Small construction contractors cannot send waste in public container parks. They have to pay a private collector which is more expensive. - For private CDW, there is a maximum volume allowed into the public containers parks. Private have to lend a container to a private collector which is really expensive.
Legislation	- The legal text: 9 MAI 1995. - Circulaire relative à la réutilisation de débris dans les travaux routiers et d'infrastructure. This text not only allows but also encourages the use of the recycling materials. - The legal text: 16 JUILLET 2010 – Arrêté du Gouvernement de la Région de Bruxelles-Capitale relatif à l'agrément et aux subventions des associations sans but lucratif et des sociétés à finalité sociale active dans le secteur du réemploi et du recyclage. This text specifies that government provides subsidies to nonprofit or social organizations that are active in the area of reuse and preparation for reuse.	- The procedures for approval to sorting containers on public roads are taking a lot of time. - Once the license of environment received, people has to respect a deadline to begin construction of the building. This time to begin the work does not encourage people to make selective deconstruction and material reuse. - The soil ordinance is too strict and does not encourage the recovery of soils. Moreover this ordinance is in opposition with the EoW status of concrete waste.

Table 12. Drivers and barriers to increase CDW recycling in Walloon Region (adapted from Deloitte, 2015)

Walloon Region		
Factor / characteristic / element in CDW recycling chain	**Drivers**	**Barriers**
Economy	- Treatment costs for sorted waste is less expensive than for mixed waste - Landfilling prices	
Legislation	- The legislation is strict and obliges to a high recycling rate for CDW. - The progressive landfill bans of waste. - Government provides subsidies to nonprofit or social organizations that are active in the area of reuse and preparation for reuse. - Walloon Plan Horizon 2020	- Qualiroute 2018: the public specifications for roads. This legislation is too strict. The technical specification are really high compared to the all the European specifications. This fact results from a study of Tradecowall. The main reason to be stricter in Wallonia is that there are a lot of quarries and so many sources of natural aggregates. The region should impose a minimum percentage of recycled aggregates. - No EoW criteria for recycling aggregates and other recycling materials from CDW.

I.2 The Netherlands

Construction sector data

Table 13 gives general data on the Dutch construction sector between 2005 and 2012.

Table 13. Turnover of the construction sector between 2005 and 2012 in The Netherlands (Deloitte, 2015).

Turnover construction sector	2005	2006	2007	2008	2009	2010	2011	2012
	in Millions of Euros, excl. tax							
Houses								
· New construction	12,699	13,664	14,334	14,262	12,465	10,246	11,107	9,696
· Major maintenance	6,583	6,912	7,479	7,606	6,842	6,035	6,421	5,882
· Small maintenance	5,233	5,207	5,348	5,444	5,520	5,476	5,492	5,239
Buildings								
· New construction	7,652	7,782	9,043	9,848	9,178	7,324	7,551	7,121
· Major maintenance	4,165	4,227	4,709	5,067	4,672	4,242	4,573	4,326
· Small maintenance	3,607	3,740	3,919	4,041	4,094	4,180	4,121	3,890
Civil engineering and road construction								
· New construction and major maintenance	7,920	8,340	8,340	8,949	8,868	8,460	9,145	8,541
· Small maintenance	5,700	5,894	6,118	6,210	6,403	6,166	5,993	5,735
· External subcontracting	2,572	2,659	2,835	2,929	2,686	2,377	2,413	2,160
· Total production	56,131	58,425	62,125	64,446	60,728	54,506	56,816	52,590

The production of concrete in the Netherlands was estimated at 13.5 million cubic meters in 2014 and slightly increased to 13.8 million cubic meters in 2015 (EIB, 2016). Cement production in the same period was estimated at 4.3 million tons in 2014 and 4.4 million tons in 2015 (EIB, 2016). According to ERMCO (2017), the production of ready-mixed concrete reached 6.5 million cubic meters in 2016. Consequently, the production of prefabricated concrete elements could be estimated at approximately 7 to 7.5 million cubic meters in 2015-2016. This suggests that the Dutch concrete market is nearly evenly divided between prefabricated concrete elements and ready-mixed concrete.

Production of wastes

In the Netherlands, approximately 23.8 million tons of Construction and Demolition Waste (CDW) were generated in 2014. This amount has remained relatively stable since 2000. Mineral waste for construction purposes accounted for approximately 80-85% of this total, which translates to roughly 19-20 million tons in 2014. Of this mineral waste, about 11 million tons consisted of concrete waste, making up approximately 55-60% of the mineral waste. Remarkably, approximately 97% of all CDW generated in the Netherlands is successfully recovered (Figure 13).

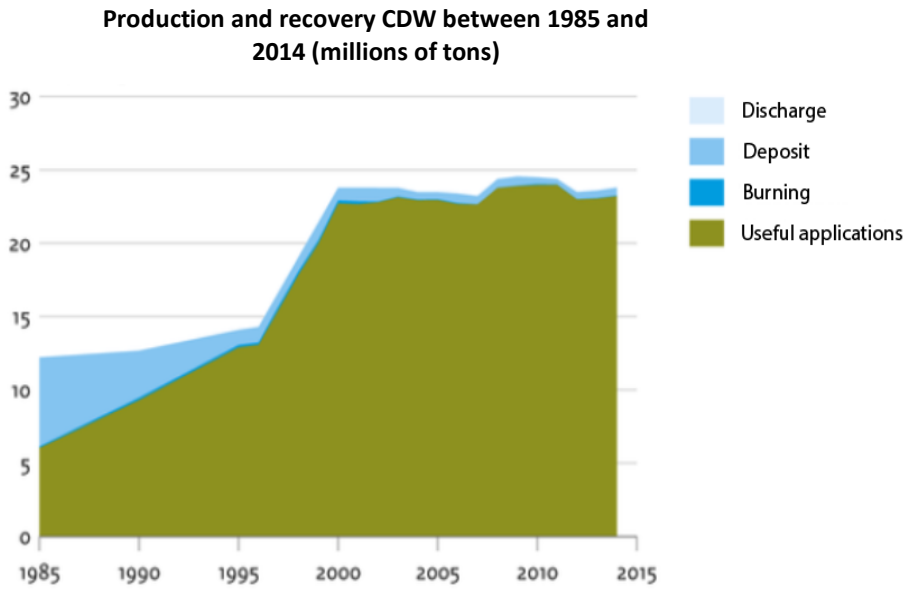


Figure 13. Production and recovery of construction and demolition waste in the Netherlands between 1985 and 2018 (Bouw- En Sloopafval: Vrijkomen En Verwerking, 1985-2018 | Compendium Voor de Leefomgeving, CBS, PBL, RIVM, WUR)

In 2015, 14.7 million tons (78 %) of CDW were recovered for foundation applications, 3.6 million tons (19 %) for backfilling/soil elevation and 0.6 million (3 %) tons for concrete (EIB, 2016).

BRBS (Brance corporation Recycling, Crushing and Sorting) has made an indication on the available amounts of building- and demolition wastes in the period 2018 – 2030, as shown in Table 14. A clear increase in the amount of available concrete rubble can be observed over the years. One of the major concerns includes the possibility of contamination of the concrete material, which makes it difficult to separate these materials and therefore the amount of usable material can in theory be lower.

Table 14: Available amount of concrete rubble 2018 – 2030 (Broere, P. Uitvoeringsteam Betonstromen. D.d. 19 may 2019); (Betonakkoord, 2021)

Material	2018	2020	2025	2030
Total construction waste [Mton]	19	20	22	25
Concrete waste [Mton]	11,4	12	13,2	15

Production of recycled aggregates and sands

A part of concrete and bricklaying sand are obtained from secondary materials which are obtained from building and demolition waste. Due to the increase of housing shortage the trend of building and renovating houses is continuing. The total amount of concrete and bricklaying sand is, however, lower due to the shift of new-built houses towards more innovative construction ideas such as 3D printing, which require less materials. Due to the successful stimulation of secondary materials, and innovations in separation

techniques due to which demolition wastes could easily be separated, much more demolition wastes can be re-used in the concrete industry nowadays. Figure 14 shows an overview of the material recycling rates per sector in 2016 in the Netherlands. Up to 38% of the total recycled material comes from the construction industry (CBS, 2019).

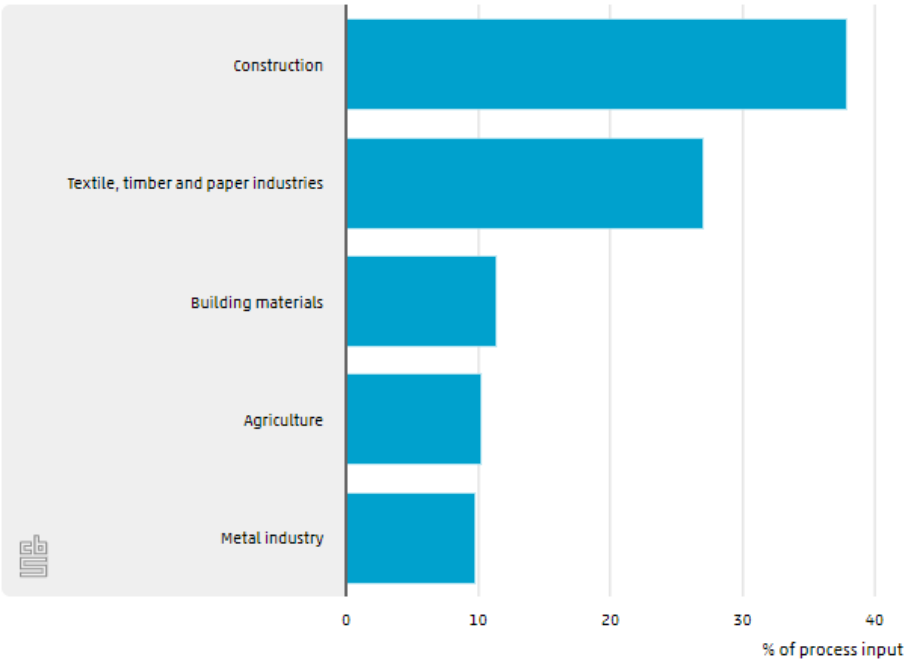


Figure 14. Recycling rates per sector in 2019 (CBS, 2019)

BRBS ("Recycling, Branchevereniging Breken en Sorteren") is the national federation representing CDW recyclers in the Netherlands. This association comprises approximately 70 members operating in over 150 locations across the country. Collectively, they process more than 75% (around 18 million tons) of the total volume of CDW generated in the Netherlands. These member companies can be categorized into three groups: crushing recycling plants (35%), sorting recycling plants (20%), and combined crushing and sorting recycling plants (45%). The recycling facilities belonging to Dutch BRBS members are strategically located throughout the country (as shown in Figure 15). CDW recycling plants are distributed widely, with a higher concentration near major cities such as Amsterdam, Arnhem, Eindhoven, Hengelo, Maastricht, Rotterdam, and Utrecht.

Feedback from Dutch producers of recycled aggregates and sands suggests that the market for these recycled products differs between the western and eastern parts of the country. In the eastern part, there is a higher demand for recycled products compared to production capacity, while in the western part, the opposite situation exists, with more production than demand. This regional disparity may present challenges for recycled products in the national market.

Figure 15. Location of BRBS's members (CDW recycling plants) in The Netherlands (BRBS, www.brbs.nl/).

Figure 16 shows the overall use of primary and secondary sand in the Netherlands over the years.

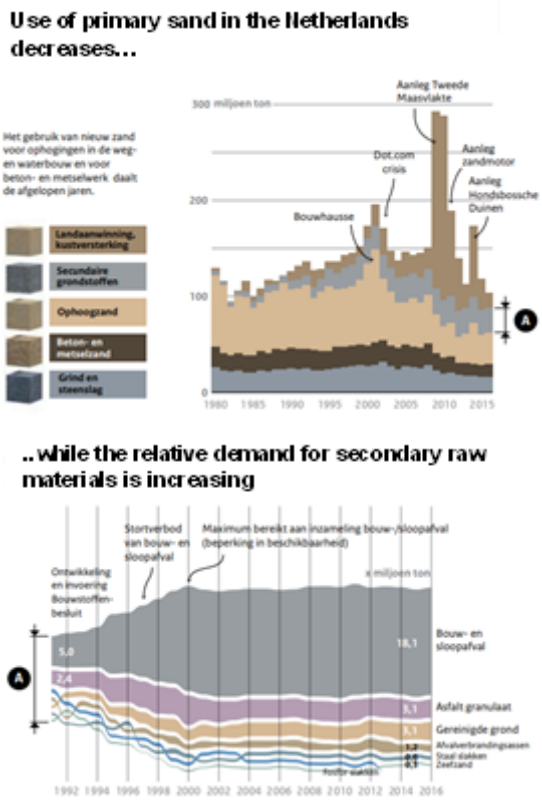


Figure 16: Usage of sand in the Netherlands 1980 – 2016 (RWS Lichtkorrel zandtekort, 2003)

In 2019 and 2020 there has been a broad discussion in the Netherlands with respect to the '*Betonakkoord'.* This agreement focusses on creating a sustainable sector by 2030, mainly focusing on reuse and recycling of concrete. The ambition is to reuse 100% of all concrete streams in new concrete by 2030 (Betonakkoord, *Roadmap Hergebruik Betonreststromen*, 2021)

Figure 17 shows a prognose of the minimum and maximum production capacity of recycled sand by recycling companies which can be reached in 2030. It can be concluded that within the Netherlands smart investments should be done to fulfill the complete sand demand by 2030.

For the conventional methods a distinction can be made between coarse materials (60%, > 4 mm) and fine materials (40%, < 4 mm). These recycled concrete aggregates are mainly applied as filler material in e.g. roads. However, in order to use crushed concrete as component in new fresh concrete mixtures, more efficient crushing and milling techniques should be applied in order to improve the recycling process of fines such as sand (Florea et al., 2012).

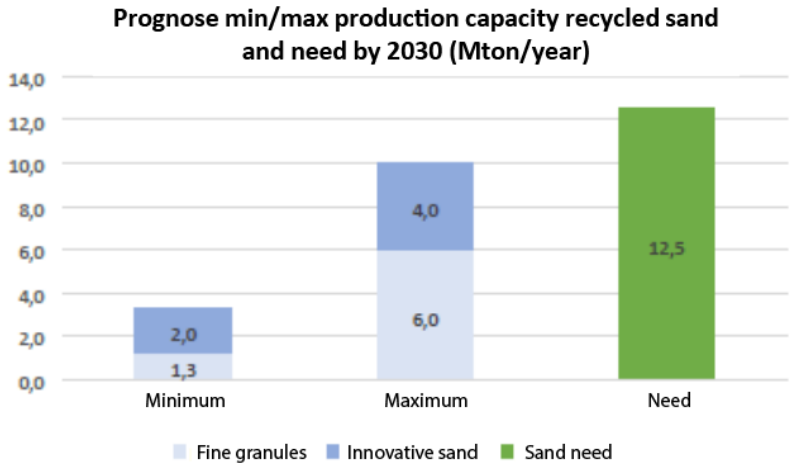


Figure 17: Prognose min. and max. production capacity of recycling companies and demand by 2030 (Betonakkoord, 2021)

Landfilling

The Netherlands adheres to a principle that mandates the recovery of all Construction and Demolition Waste (CDW) and landfilling of such waste is prohibited. An exception to this prohibition can be granted by the Federal States (Provinces) if waste processors have less capacity than the waste supply. This approach is in line with the Dutch strategy, which allows landfilling only for waste streams that cannot be recovered or incinerated. This strategy is commonly referred to as "the order of preference." (RE^4 project, 2017).

Extractive industry

For geological reasons, natural sands and aggregates are mainly extracted from Dutch rivers on floating/mobile plants. Coarse aggregates are mainly extracted in the South part of the country (Limburg) and finer fractions generally come from the Northern part of the country and from the North Sea (source: Cascade-zandgrind.nl).

Figure 18 shows an overview of the availability of fine sand, coarse sand, and gravel in the Netherlands. Clay, sand, and gravel are the major materials present in Dutch soil in various regions. Usable clays and coarse industrial sand can be found in the east and south of the Netherlands along the Rhine and Meuse rivers due to the good drainage possibilities. These sands can for example be used for making concrete. In South-Limburg, more upstream of the Meuse, gravel and marl can be found. Fine filler sand can be found all over the country, especially near the Ijsselmeer and North Sea (’t Hoen, 2017).

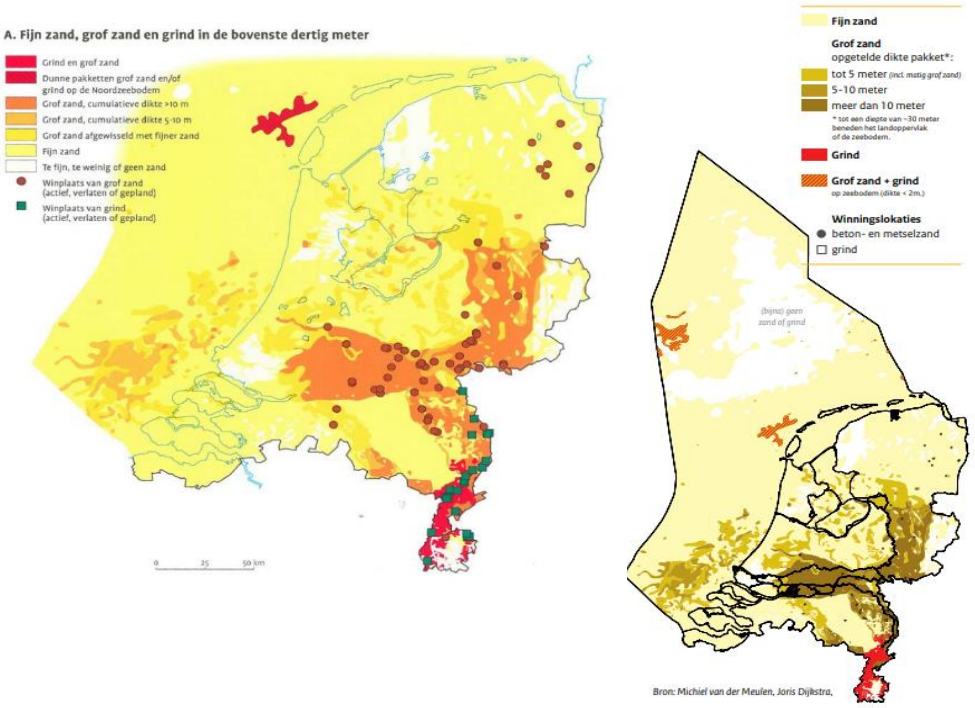


Figure 18. Availability of sand and gravel in Dutch soil (Kok, L., Sipman, L., van Mullekom, 2015); (Van der Meulen, M., Dijkstra, J. TNO. (2005))

Over the past decade, the regular extraction of primary building materials in the Netherlands has ranged from about 55 to 88 million tons per year , as shown in Figure 19. Approximately 7% of the extracted materials consist of coarse aggregates (mainly gravel), 18% are fine aggregates (mainly concrete and masonry sand), 66% are backfilling sand, and 9% are other building materials (other industrial sand, clay, and marl). Only a small part of these extracted materials are sands which can be used for building purposes.

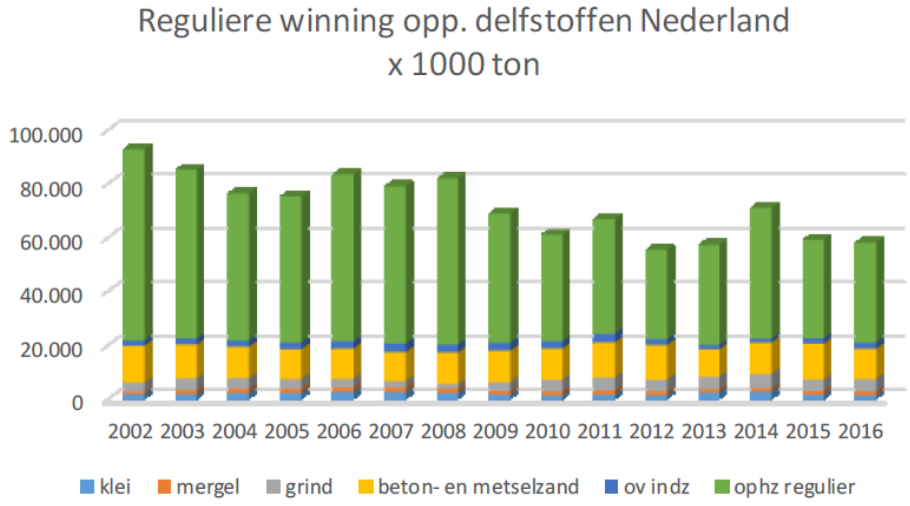


Figure 19: Regularly extracted materials between 2002 and 2016 (H2H report, 2017).

The regular consumption of primary and secondary building materials in the Netherlands for the period 2015-2016 totaled 67-69.5 million tons. Approximately 74% of this quantity was sourced from within the Netherlands, while the remaining 26% was imported from neighboring countries, including Germany, Belgium, and the UK. These imported building materials are essential because they are either not available or not

sufficiently available in the Netherlands. Examples of such materials include gravel, crushed rocks, and coarse concrete aggregates ('t Hoen, 2017).

The need for construction sand between 1980 and 2012 is shown in Figure 20, varying between 17 and 26 MTon per year. Yearly, approximately 14 - 22 MTon of concrete and bricklayers' sand is extracted. After 2002 a clear decrease can be observed, which can be related to a change in policy due to the encouragement of using more secondary materials. However, the need for materials was especially filled by importing sand from other countries (Kok, L., Sipman, L., van Mullekom, 2015). The extraction of sand for especially concrete production purposes is 19-23% of the total Dutch extraction ('t Hoen, 2017).

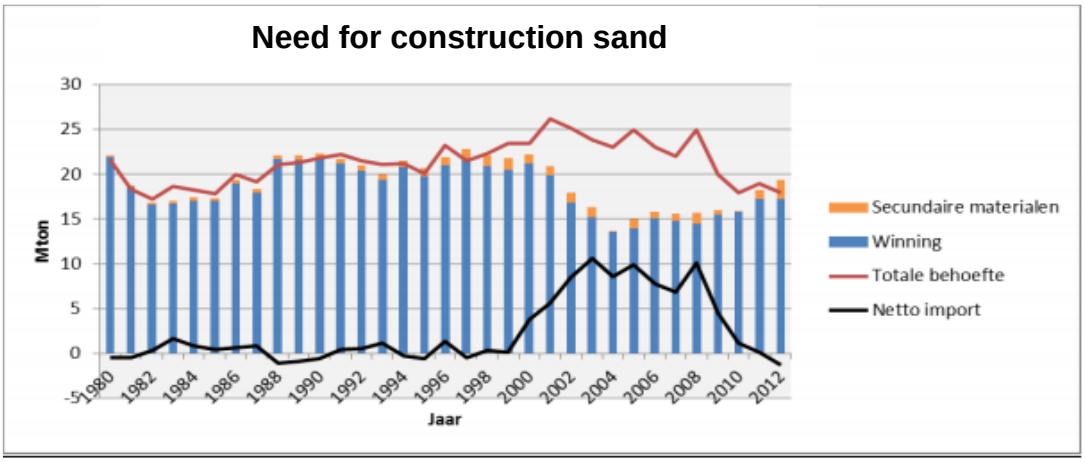


Figure 20: Need for construction sand in the Netherlands between 1980 and 2012 (Kok, L., Sipman, L., van Mullekom, 2015)

Table 15 show an overview of the distribution of material extraction from the soil as well as exports and imports of these materials on the Dutch market, according to the kind of material. Most sands for the building industry are extracted in Gelderland and Limburg.

Table 15. Amount of primary and secondary raw materials for construction consumed (verbruik) and extracted (winning/productie) in the period 2015-2016 (in million tons) (H2H report, 2017).

Resultaat monitoring bouwgrondstoffen over 2015-2016 (x miljoen ton)

	2015				2016			
	verbruik	import	export	winning/ productie	verbruik	import	export	winning/ productie
bouwgrondstoffen regulier								
grof granulaat								
grind	9,5	5,2		4,3	10,0	5,4		4,6
gebr.grind/ steenslag	6,7	6,1		0,6	7,0	6,0		1,0
fijn granulaat								
beton- en metselzand	12,9	4,5	5,0	13,4	13,6	4,7	2,3	11,3
ophoogzand								
ophoogzand regulier	31,1		5,4	36,5	32,1		5,0	37,1
overige bouwgrondstoffen								
kalkzandsteen	1,6			1,6	1,9			1,9
zilverzand	1,2	0,8		0,4	1,3	0,8		0,5
klei	2,5	0,8		1,7	2,2	0,8		1,5
mergel	1,3			1,3	1,4			1,4
Totaal regulier	**66,8**	**17,3**	**10,4**	**59,8**	**69,5**	**17,6**	**7,3**	**59,2**
bouwgrondstoffen niet-regulier								
Noordzee kustverdediging	30,2			30,2	15,3			15,3
Noordzee landaanwinning	2,5			2,5				
Totaal niet regulier	**32,7**			**32,7**	**15,3**			**15,3**
Totaal primaire bouwgrondstoffen	**99,5**	**17,3**	**10,4**	**92,5**	**84,8**	**17,6**	**7,3**	**74,5**

Figure 21 provides a visual representation of extractive activity based on regions and the types of extracted materials during the period of 2015-2016. It is evident from the figure that, during this period, the majority of building materials were extracted in the provinces of Limburg and Gelderland, with some extraction occurring in Brabant, Overijssel, Drenthe, Groningen, and Friesland. Additionally, significant quantities of backfilling sand were extracted from the North Sea and IJsselmeer during this timeframe.

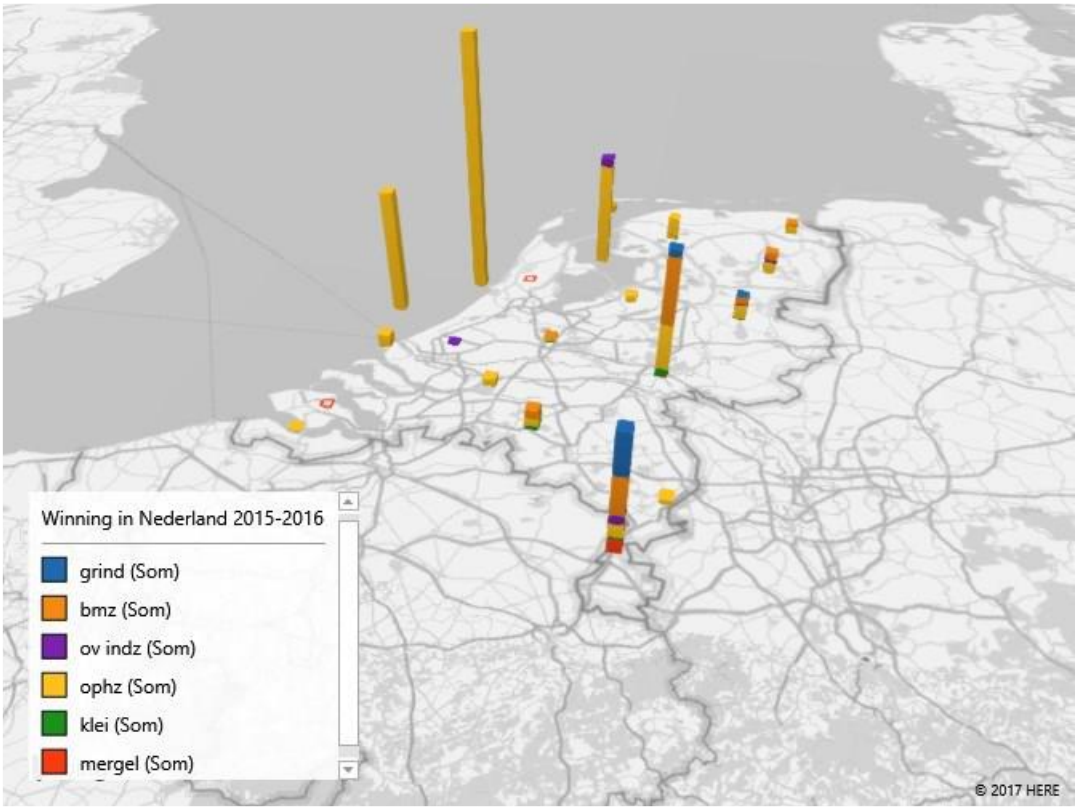


Figure 21. Distribution of extracted materials according to regions (grind = gravel; bmz = concrete and masonry sand; ov indz = other industrial sand; ophz = backfilling sand; klei = clay; mergel = marl) (H2H report, 2017).

The extraction of **gravels** varies between 4.5 and 5 million tons per year (see Table 16 for details). The overview shows that over 85% of the Dutch gravel is extracted in Limburg.

Table 16. Extraction of gravels between 2009 and 2016 (in thousand tons) (H2H report, 2017).

	2009	2010	2011	2012	2013	2014	2015	2016
provincies								
Overijssel	33	36	31	32	24	39	51	47
Gelderland	243	289	409	448	403	478	594	583
N-Brabant	151	319	317	340	213	110		
Limburg	2.820	3.615	4.168	3.625	3.960	4.568	3.675	3.941
Totaal provincies	**3.247**	**4.259**	**4.925**	**4.445**	**4.600**	**5.195**	**4.320**	**4.571**
rijkswateren								
Bovenrivieren		100						
Totaal grind	**3.247**	**4.359**	**4.925**	**4.445**	**4.600**	**5.195**	**4.320**	**4.571**

The production of **concrete and masonry sand** in the Netherlands varies between 11 and 13.5 million tons per year (Table 16). The overview shows that 79 % of recycled sand is produced in the provinces of Gelderland and Limburg (South-East part of the country). Then 14 % is produced in the Northern provinces (Groningen, Drenthe and Overijssel) and about 7 % in Brabant.

Table 17. Production of concrete and masonry sand between 2009 and 2016 (in thousand tons) (H2H report, 2017).

	2009	2010	2011	2012	2013	2014	2015	2016
provincies								
Groningen	414	346	250	251	302	322	303	276
Drenthe	763	675	864	817	624	519	697	815
Overijssel	808	611	702	684	722	854	609	664
Gelderland	3.403	3.484	4.702	4.679	3.610	4.738	7.629	4.716
Utrecht	530	820	590	247	211	550	133	
N-Brabant	1.600	1.962	2.203	2.173	1.425	1.100	682	920
Limburg	4.214	2.908	3.659	3.013	3.343	3.656	3.310	3.859
Totaal provincies	**11.732**	**10.806**	**12.970**	**11.864**	**10.237**	**11.739**	**13.363**	**11.250**
rijkswateren								
Totaal rijkswater		805		1000				
Totaal beton en metselzand	**11.732**	**11.611**	**12.970**	**12.864**	**10.237**	**11.739**	**13.363**	**11.250**

The regular extraction of **backfilling sand** makes up 60-70% of the regular Dutch production of surface minerals (see Table 18 and Table 19 for details). This extraction takes place at land locations and in rivers. The regular extraction of backfilling sand is also the extraction of fine sand in the North Sea, which is partly used in Belgium as stabilization sand in road construction.

Table 18. Production of backfilling sand between 2002 and 2016 (in thousand tons) (H2H report, 2017).

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
prov regulier	27.150	22.420	24.550	23.825	28.605	24.605	23.780	19.729	16.700	17.435	10.391	12.747	14.343	12.219	13.323
rijksw regulier	43.794	40.302	30.099	30.529	33.405	33.800	38.088	28.322	22.914	25.215	22.766	24.335	34.192	24.312	23.754
Noordzee kustverdediging	27.540	17.850	18.020	26.010	19.550	25.840	22.100	52.588	37.484	63.399	14.623	21.297	68.680	30.214	15.307
Noordzee landaanw.								132.285	155.428	26.627	40.746	3.330	5.771	2.477	
Nederland	**98.484**	**80.572**	**72.669**	**80.364**	**81.560**	**84.245**	**83.969**	**232.924**	**232.526**	**132.676**	**88.527**	**61.709**	**122.985**	**69.222**	**52.384**
wv winning regulier	*70.944*	*62.722*	*54.649*	*54.354*	*62.010*	*58.405*	*61.869*	*48.051*	*39.614*	*42.650*	*33.157*	*37.082*	*48.535*	*36.531*	*37.077*

Table 19. Production of backfilling sand between 2009 and 2016 (in thousand tons), according to locations (H2H report, 2017).

	2009	2010	2011	2012	2013	2014	2015	2016
provincies								
Groningen	1.224	896	772	642	1.009	903	822	829
Friesland	2.046	2.355	1.345	298	1.059	1.660	2.130	2.339
Drenthe	2.219	1.862	1.792	1.320	1.596	1.320	1.054	1.161
Overijssel	2.433	2.075	1.492	2.237	2.825	3.563	1.488	1.325
Flevoland					674	510	790	451
Gelderland	2.616	2.351	3.412	3.170	3.074	3.022	3.233	5.362
Utrecht	1.420	2.020	2.130	311	234	701	574	
Z-Holland	937			600				
N-Brabant	5.981	3.796	5.518	935	1.172	1.369	810	661
Limburg	853	1.345	974	878	1.104	1.295	1.318	1.195
Totaal provincies	**19.729**	**16.700**	**17.435**	**10.391**	**12.747**	**14.343**	**12.219**	**13.323**
rijkswateren								
Ijsselmeer + Randmeren	5.533	4.235	5.123	4.975	5.907	17.695	10.149	9.073
Bovenrivieren					598	1.461	1.131	306
Benedenrivieren	481	185	162	197	567	586	386	474
Waddenzee	662	495	932	687	673	691	578	855
Westerschelde/Delta	2.768	2.605	2.330	2.059	2.496	1.047	31	233
Noordzee	203.751	208.306	106.694	70.218	38.720	87.162	44.023	26.678
overig rijkswateren							706	1.442
Totaal rijkswateren	**213.195**	**215.826**	**115.241**	**78.136**	**48.962**	**108.642**	**57.003**	**39.061**
Totaal ophoogzand	**232.924**	**232.526**	**132.676**	**88.527**	**61.709**	**122.985**	**69.222**	**52.384**
wv reguliere winning	48.051	39.614	42.650	33.157	37.082	48.535	36.531	37.077
wv Noordzee kustverdediging	52.588	37.484	63.399	14.623	21.297	68.680	30.214	15.307
wv Noordzee landaanwinning	132.285	155.428	26.627	40.746	3.330	5.771	2.477	
wv export naar België [1)]	8.145	6.642	7.192	6.407	6.454	6.085	5.411	4.976

Marine Sand extraction

Based on the Dutch laws, sand extraction can be done in a region between the 12-mile border and NAP -20m. The total area of this sand extraction area is 5134 m^2. Within this area, sand extraction is of main business. However, large-scale sand exploitation at a depth > 2 meters is allowed only from 2 km onwards from the current NAP -20m border. Most of the sand extracted from the sea is nowadays applied for coastal maintenance (12 million m^3 per year) and filling sand on shore (13 million m^3 per year) (*Oppervlaktedelfstoffenwinning - Noordzeeloket*, n.d.) By replacing sand closer to the coastal line, inland movement of the Dutch coastal line will be prevented. To assure sand extraction is done in the right way, a Sand Extraction Strategy has been set up which is based upon a balanced consideration of all relevant interests. Rijkswaterstaat Sea and Delta is primarily responsible for strategic management of sand extraction in these areas, assuring efficient use of the reserved materials over space and time. The average depth of a sand extraction pit is 2 meters, as this restriction increases the efficiency of sand supply usage. At the moment, the used sand extraction regions can supply the Netherlands at

least for the coming century with sand. Figure 22 shows an overview of the possibilities for extracting sands from the North Sea (Rijksoverheid Noorzeeloket, 2015).

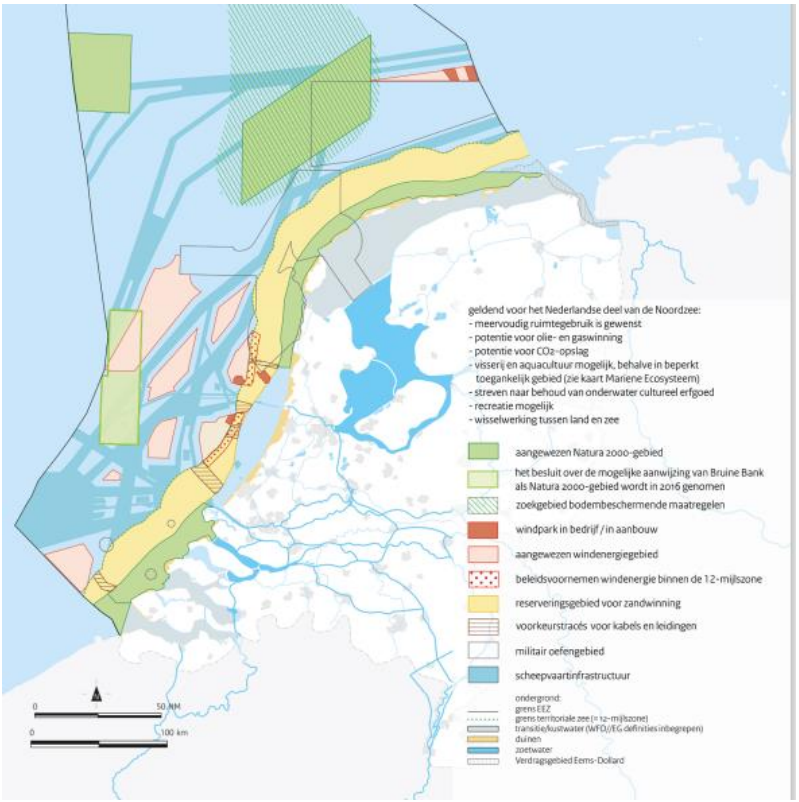


Figure 22. Structural vision map North Sea. (Rijksoverheid Noorzeeloket, 2015)

Export/import:

Gravels (*grind*) are mainly imported from UK/North Sea and Germany according to quantities mentioned in Table 20.

Table 20. Importation of gravels (*grind*) according to exportation statistics (H2H report, 2017)

	x mln ton							
Import grind	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
UK/Noordzee [1)]	1,9	1,5	1,7	1,1	0,9	0,7	0,4	0,6
Duitsland [2)]	10,1	8,0	7,6	7,1	5,5	5,0	4,2	4,2
Import totaal	**12,0**	**9,5**	**9,3**	**8,2**	**6,4**	**5,7**	**4,6**	**4,9**

[1)] bron: The Crown Estates (UK), waarvan aanname 55% grind

[2)] bron: Bundesanstalt für Geowissenschaften und Rohstoffe

Crushed gravels importation estimated from the application of this material is mention in Table 21. However, these data are quite different from data compiled from the export statistics and mentioned in Table 22. This difference is probably related to the use of a large amount of crushed gravels for road, railway and hydraulic construction purposes. Data on Table 22 would be closer to the real amount of imported materials. Imported crushed gravels come from Belgium (4.0-4.5 million tons), Norway (3.0-3.5 million tons), Germany (2.5 million tons) and Scotland (1.0 million tons). About 55 to 60 % of these materials are used for concrete and asphalt applications.

Table 21. Estimation of the Dutch supply for crushed gravels (H2H report, 2017).

Steenslag/ gebroken grind	x mln ton							
	2009	2010	2011	2012	2013	2014	2015	2016
productie	0,8	0,5	0,8	0,6	0,5	0,5	0,6	1,0
import	5,9	5,6	5,7	5,6	5,5	5,7	6,1	6,0
verbruik	6,7	6,1	6,5	6,2	6,0	6,1	6,7	7,0

Table 22. Importation of crushed gravels according to exportation statistics (H2H report, 2017).

Import gebr. rots/ natuursteen	x mln ton							
	2009	2010	2011	2012	2013	2014	2015	2016
Duitsland [1]	2,6	3,6	3,1	2,8	2,9	3,0	2,3	2,4
België [2]	3,5	3,9	4,0	4,0	3,8	4,0	4,5	3,9
Noorwegen [3]	3,1	5,5	4,6	3,0	2,9	2,7	2,9	3,6
Schotland [4]	1,4	1,5	1,6	1,2	1,0	0,9	1,0	1,1
Import totaal	**10,6**	**14,5**	**13,3**	**11,0**	**10,7**	**10,6**	**10,7**	**11,0**
wv voor beton & asfalt	5,9	5,6	5,7	5,6	5,5	5,7	6,1	5,9
wv overige toepassingen	4,6	9,0	7,6	5,4	5,1	5,0	4,6	5,1

[1] bron: Bundesanstalt für Geowissenschaften und Rohstoffe

[2] bron: Jaarverslagen FEDIEX, Federation de l'Industrie Extractive

[3] bron: Geological Survey of Norway (NGU)

[4] bron: raming op basis NVLB cijfers over Schotse import

Table 23 summarizes importation and exportation of **concrete and masonry sand**. Estimated data on imported materials are in agreement with the exportation statistics (Table 25).

Table 23. Data on production (*winning*), supply (*verbruik*) and export/import of concrete and masonry sand (H2H report, 2017).

beton- en metselzand	x mln ton							
	2009	2010	2011	2012	2013	2014	2015	2016
winning	11,7	11,6	13,0	12,9	10,2	11,7	13,4	11,3
import	8,3	8,4	8,6	6,2	5,6	5,0	4,5	4,7
export	2,2	4,2	4,2	4,3	2,3	3,3	5,0	2,3
verbruik	17,9	15,8	17,3	14,7	13,5	13,5	12,9	13,6

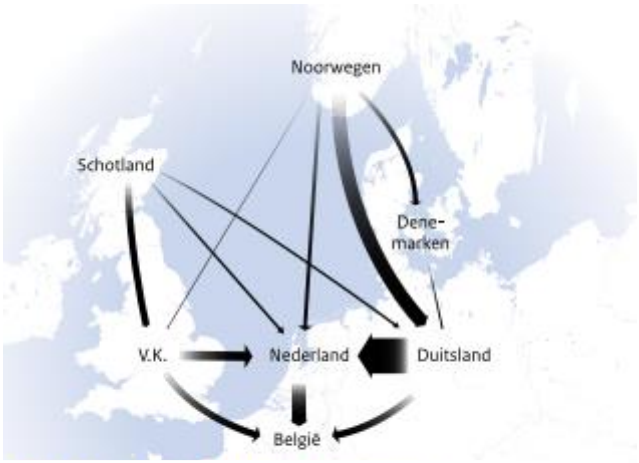
Table 24. Origin of imported concrete and masonry sand according to exportation statistics (H2H report, 2017).

Import beton- en metselzand	x mln ton							
	2009	2010	2011	2012	2013	2014	2015	2016
UK/Noordzee [1]	1,6	1,2	1,4	0,9	0,8	0,6	0,3	0,5
Duitsland [2]	6,8	7,2	7,2	5,2	4,8	4,5	4,2	4,2
Import totaal	**8,3**	**8,4**	**8,6**	**6,2**	**5,6**	**5,0**	**4,5**	**4,7**

[1] bron: The Crown Estates (UK), waarvan aanname 45% beton- en metselzand

[2] bron: Bundesanstalt für Geowissenschaften und Rohstoffe

Figure 23 shows the net trade flows in sand and gravel from and towards the Netherlands.



Net trade flows sand and gravel

Figure 23: Net trading streams in sand and gravel (Van der Meulen et Al., RWS Lichtkorrel zandtekort, 2003)

Conclusion

In the Netherlands, annual concrete production ranges from approximately 13.5 to 14.0 million tons. The majority of this concrete is used for precast concrete products (CPPs), with the remainder being used for ready-mixed concrete. Out of the total concrete produced, around 0.6 million tons incorporate recycled sands and aggregates, which account for 3% of the 18 million tons of recycled construction and demolition waste (CDW) generated annually. These recycled materials are sourced from 150 recycling plants (including crushing, sorting, and combined facilities) located throughout the country, with a significant portion originating from the southeastern regions of Gelderland and Limburg.

The Netherlands has regulations prohibiting the landfilling of most CDW, and national policies and long-term objectives have contributed to the growth of the market for recycled products, promoting the principles of the circular economy within the construction sector.

The primary raw materials used in construction, particularly coarse and fine sands, face challenges in terms of supply. The total extraction of regularly used primary raw materials ranges from 55 to 80 million tons, with backfilling sand accounting for approximately 66% of this activity. The supply of coarse aggregates, mainly sourced from Limburg in the southeastern part of the country, constitutes only 7% of the total supply, resulting in a significant demand-supply gap for coarse aggregates. To meet this demand, around 70% of coarse aggregates are imported from countries such as Germany, Belgium (Wallonia), Norway, Scotland, and the UK, often requiring transportation over distances exceeding 100 kilometers.

Given the current demand for natural raw materials outstripping domestic supply, the market for recycled aggregates is favorable at the national level. Recycled materials make up approximately 20-35% of the regularly extracted primary raw materials.

The drivers and barriers influencing the need for increased CDW recycling in the Netherlands are outlined in Table 25.

Table 25. Drivers and barriers to increase CDW recycling in The Netherlands (Deloitte, 2015).

Factor / characteristic / element in CDW recycling chain	Drivers	Barriers
Market conditions	-Builders are positive about buying secondary materials because the quality is good compared to the price. -If the quality of the materials would be assured by a quality label, then builders are willing to use the materials - Cost reduction is an important driver for good CDW management. E.g.: Constructors focus on the separation of waste at the source, in order to minimize logistics. Separation is cheaper than not separating - Client more and more ask for buildings with renewable labels	-The supply of secondary materials is not yet big enough -There are no clear quality gradations for the recycled materials - The market still mainly focuses on standalone unit prices, such as the price of a container, instead of the total cost with regards to the process of waste recycling - The market still has much trouble with such innovative new ideas, such as a business model in which a building remains in possession of the builder (producer) instead of the user. - A solid business case for recycling materials has to exist in order to really grow to full potential
Legislation	-The introduction of tax on landfilling and burning waste is an enabler of more recycled CDW. -Most of the landfilling is banned, but if more options would be are banned, the market will recycle even more waste. -Prohibition of waste burning is a major driver for waste recycling	-The law and regulations are often linear (not circular). E.g.: the use of display glass in concrete is allowed, only the concrete is not recyclable anymore, because the glass is heavily polluted. The final recyclability is not taken into account. - Burning of waste is still allowed, this should become prohibited, since it goes against recycling, and pulls waste.
Initiatives	- The BREEAM certificate works well as a driver to make buyers and constructors of buildings want to spend more money in order to make a building more sustainable	-There is much knowledge developed, but the actual commitment to each other how to handle CDW takes commitments from the clients and contractors. -Projects are currently all still very much in its infancy.
Prevention of waste	- Adaptive building is a major driver for prevention of waste.	-If materials are recycled, it still costs CO2. It is better to reuse building components -About preventing CDW: a lot can be controlled already in the contracts and tenders, in order to prevent waste / setting requirements for what materials and which design methods may be used.
Bureaucracy		-The government is not one party (RWS, municipalities, provinces). In many municipalities there is currently a struggle because of shortage of people and hours, and knowledge. -Local authorities and municipalities don't have much knowledge. The knowledge should she be better provided by the national government -The load for the project-level to provide feedback on how was performed with regard to sustainability
Culture		-According to interviewed stakeholders, the traditional nature of the construction sector holds back the full potential of recycling CDW. People do not think about making the waste recycling processes better.

I.3 France

Construction sector data

In France, the building sector plays a significant role in the country's economy. According to the Building French Federation (FFB), the sector had a turnover of 135 billion euros (excluding TAV) and employed approximately 1,069,000 individuals across 392,000 companies in 2017.

Within the building sector, the French Concrete Industry Federation (FIB), representing the Concrete Prefabricated Products (CPPs) segment, is notable. FIB reported a turnover of 2.37 billion euros and a total volume of 19 million tons of concrete products. This sector comprises around 17,500 direct jobs within 500 companies, operating across 770 production sites throughout France.

The French CPP market is categorized into three primary segments:

- Small Building Elements: This category accounts for the majority, representing 52.2% of the total mass of CPPs. The main products in this category are blocks. Despite their high quantity, small building elements contribute the least to the overall turnover, making up only 26.6%.
- Large Building Elements: Large building elements constitute 17.5% of the total mass of CPPs produced in France. This category mainly includes structural elements. Although these elements represent a smaller portion by mass, they contribute significantly to the annual turnover, accounting for one-third of the total.
- Products for Public Works and Environment: Products for public works and the environment make up 30% of the total amount of concrete used for prefabricated elements. Road elements, in particular, are a significant component of this category, and they contribute to 40% of the overall turnover in the CPP market.

The distribution of the market for prefabricated concrete elements in France can vary based on both the amount of concrete elements produced and the turnover associated with each type of concrete element. The specific proportions for each type can be found in the relevant reports and data sources mentioned.

In France, the production of ready-mixed concrete has shown a steady increase over the years. In 2016, the production of ready-mixed concrete reached 36.3 million cubic meters, a significant volume. This growth trend is noteworthy when compared to the situation in 1994. This increase in ready-mixed concrete production reflects the demand for concrete in various construction applications.

When considering the total production of concrete in France, which includes both ready-mixed concrete and prefabricated concrete elements, the estimated volume is approximately 44.2 million cubic meters. This indicates that ready-mixed concrete contributes significantly to the overall concrete production in the country, accounting for more than 80% of the total concrete produced.

This data underscores the importance of ready-mixed concrete in the French construction sector and its substantial role in meeting the concrete needs for various construction projects across the country.

EN TONNAGE

			VENTES EN M.T.	%
VENTES TOTALES DES PRODUITS EN BÉTON 21,3 M.T.	PETITS ÉLÉMENTS DE CONSTRUCTION 11,1 M.T. 52,2 %	BLOCS	9,5	44,6
		POUTRELLES HOURDIS TUILES	1,6	7,6
	GRANDS ÉLÉMENTS DE CONSTRUCTION 3,8 M.T. 17,5 %	ÉLÉMENTS ARCHI.	1,0	4,8
		ÉLÉMENTS DE STRUC. GRANDS PLANCHERS	2,2	10,5
		CONDUITS ET GAINES	0,1	0,1
		ELE.DE CONST.LEGERS	0,3	1,2
		DIVERS	0,2	0,9
	PRODUITS DE T.P ET D'ENVIRONNEMENT 6,4 M.T. 30,3 %	ENSEMBLE (1) TUYAUX & ACCESSOIRES	1,7	8,2
		ÉPURATION	0,1	0,5
		VOIRIE (2)	3,4	16,1
		CLÔTURES	0,3	1,2
		DIVERS	0,9	4,2

(1) Y compris les chambres de tirage (Télécom)
(2) Y compris les traverses S.N.C.F

EN EUROS

			C.A. HT DÉPART M.€	%
C.A. HT DÉPART DES PRODUITS EN BÉTON 2 566,6 M.€	PETITS ÉLÉMENTS DE CONSTRUCTION 682,0 M.€ 26,6 %	BLOCS	428,2	16,7
		POUTRELLES HOURDIS TUILES	253,8	9,9
	GRANDS ÉLÉMENTS DE CONSTRUCTION 870,8 M.€ 33,9 %	ÉLÉMENTS ARCHI.	313,5	12,2
		ÉLÉMENTS DE STRUC. GRANDS PLANCHERS	411,9	16,0
		CONDUITS ET GAINES	7,6	0,3
		ÉLÉMENTS DE CONSTRUCTION LÉGERS	51,5	2,0
		DIVERS	86,3	3,4
	PRODUITS DE T.P ET D'ENVIRONNEMENT 1013,8 M.€ 39,5 %	ENSEMBLE (1) TUYAUX & ACCESSOIRES	256,6	10,0
		ÉPURATION	30,4	1,2
		VOIRIE (2)	410,0	16,0
		CLÔTURES	63,9	2,5
		DIVERS	252,9	9,8

(1) Y compris les chambres de tirage (Télécom)
(2) Y compris les traverses S.N.C.F

Figure 24. Details on the market of prefabricated concrete elements in France in 2013 (FIB, 2013). On the left: the amount of concrete elements produced (in million tons); on the right: the turnover for each type of concrete elements produced on the French market (in million euros, excl. VAT).

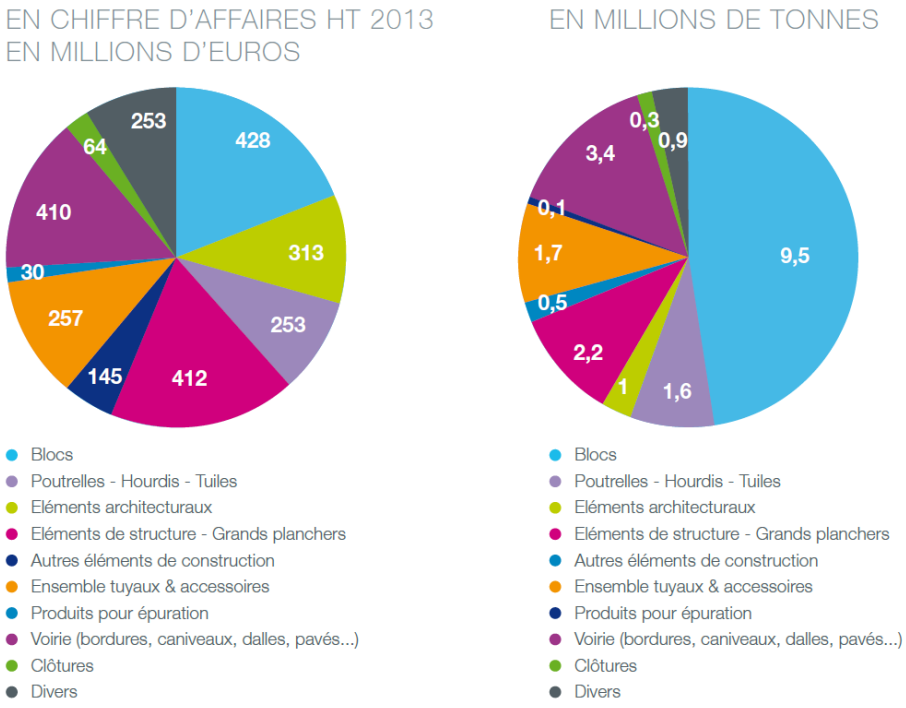


Figure 25. Distribution of the market of prefabricated concrete elements in France in 2013 (FIB, 2013). On the left: the turnover for each type of concrete elements produced on the French market (in million euros, excl. VAT); on the right: the amount of concrete elements produced (in million tons).

Production of wastes

The generation of construction and demolition waste (CDW) in France is a significant part of the country's total waste production. As of 2012, the total production of wastes in France amounted to 345 million tons, and a substantial portion of this waste, approximately 247 million tons, originated from the building sector. CDW accounts for a substantial proportion of the waste generated in France [Table 26] (Deloitte, 2015).

Inert wastes make up a substantial portion of CDW and represent a significant share of the total waste generated in the building sector. Approximately 70% of the total wastes in France are categorized as inert wastes. These inert wastes include materials that are not chemically reactive and do not easily decompose. Among the inert CDW, unpolluted soil and stones are the dominant components, accounting for a substantial 70% of inert CDW. These materials are typically generated from activities such as earthmoving and demolition work [Table 27] (Deloitte, 2015).

Table 26. The French official CDW generation between 2006 and 2012 (Deloitte, 2015).

Year	2006**	2008***	2008**	2008*	2010*	2010	2012
Inert waste (Mt)	347.50	238.72	238.15	238.2	243.4	243.4	231.2
Non-inert non-hazardous waste (Mt)	8.47	13.23	12.37	12.4	14.3	14.7	13.1
Hazardous waste (Mt)	2.91	2.55	2.52	2.5	2.6	2.6	2.4
Total (Mt)	358.88	254.5	253.04	253.0	260.2	260.7	246.7

To provide a breakdown of inert CDW in 2008, unpolluted soil and stones accounted for 175 million tons, constituting a majority of this waste category. If we exclude these natural materials from inert CDW, the remaining inert CDW materials amounted to approximately 67.8 million tons. Among these materials, unmixed crushed concrete and brick and tile concrete (CBTC) accounted for 32%, while mixed inert CDW represented 27%. Bituminous mixtures and other materials resulting from roadway demolition made up 15% and 19%, respectively, of inert CDW. This data suggests that CBTC, especially unmixed CBTC, constitutes a substantial portion of inert CDW in France, with an estimated production of around 38 million tons [Table 27] (Deloitte, 2015).

Table 27. Nature of inert CDW produced in 2008 (Deloitte, 2015).

Waste nature	Total quantity of waste generated (Mtonnes)
Concrete	17.84
Bricks, tiles, ceramic and slate	2.87
Glass	0.10
Bituminous mixtures containing no tar	9.30
Unpolluted soil and stones	175.11
Other materials from roadway demolition	11.82
Non polluted track ballast	0.97
Non polluted dredging spoil	2.60
Other inert wastes	1.18
Mixed inert wastes	17.09
Total inert waste	**238.89**

About 80 million tons of these 239 milliontons of inert wastes were landfilled in 2012. This represents 35 % of the total amount of inert wastes produced in France. 657 landfills class 3 (for inert wastes – "ISDI" for "installations de stockage de déchets inertes") are present in France. Figure 26 illustrates the location of these landfills.

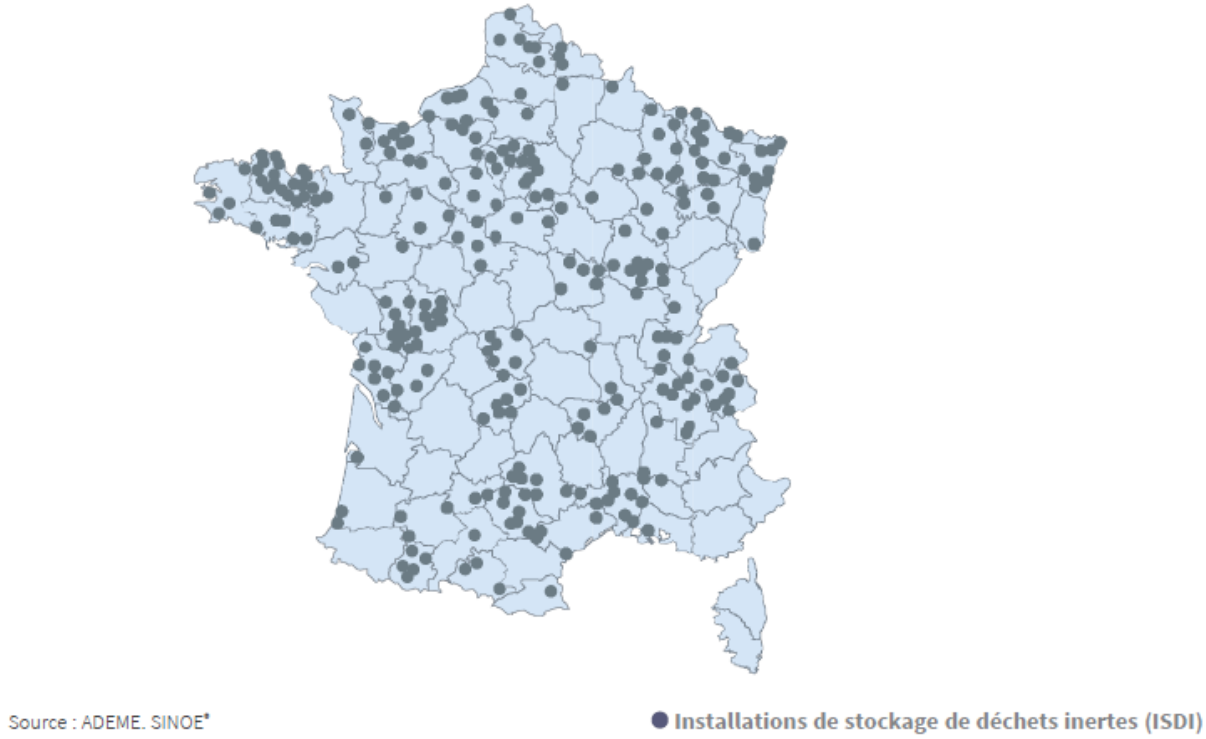


Figure 26. Distribution of landfills for inert wastes (ISDI) in France (ADEME, 2016).

There is no ban for landfilling inert CDW in France. It is widely acknowledged that the current level of landfill tax, even if steadily increasing, is not high enough to be a sufficient deterrent. It is estimated that the landfill tax only represents 10 to 30% of the total landfill prices, mainly because 90% of storage facilities benefit from tax reductions rewarding their environmental and energetic performance. It is also to be noted that France is one of the few countries in Europe with no tax on inert waste landfill (Deloitte, 2015).

These figures highlight the significant volume of CDW and inert wastes in France, emphasizing the importance of managing and recycling these materials to minimize environmental impacts and promote sustainability in the construction and demolition sectors

Production of recycled aggregates and sands

n France, the production of recycled aggregates has become increasingly important for the construction sector's sustainability efforts. In 2016, the country produced a significant volume of recycled aggregates, amounting to 25.7 million tons [UNPG, 2018]. Among this total, 21.4 million tons were sourced from demolition activities, and an additional 4.3 million tons were manufactured as recycled aggregates. This production of recycled aggregates from demolition operations represents approximately 6% of the overall production of sands and aggregates in France, including natural, manufactured, and recycled materials.

It's important to note that these figures specifically account for the quantities of recycled aggregates produced within recycling plants located in France. However, this data does not include inert materials that are recycled on-site, which is a common practice in construction and demolition activities. When considering the on-site recycling of inert materials, it is estimated that an additional 40 to 50 million tons of sands and aggregates could be attributed to the total quantity of recycled materials produced in France. Consequently, the overall volume of recycled sands and aggregates in the country could be estimated at 65 to 75 million tons. This substantial volume corresponds to approximately 15% to 20% of the total production of sands and aggregates in France [UNPG, 2018].

Recycled aggregates sourced from demolition activities can be further categorized into two primary sources. The majority, accounting for about 90%, is derived from roadway demolition projects, reflecting the significant use of recycled materials in road construction and maintenance. The remaining 10% of recycled aggregates from demolition are obtained from building demolition projects [UNPG, 2018].

To support the recycling of construction and demolition waste (CDW), France has established approximately 400 CDW recycling plants across the country. These facilities play a crucial role in sorting and recovering valuable materials from CDW. A survey conducted in 2009 by ADEME (the French Environment and Energy Management Agency) focused on 39 of these CDW sorting and recovery facilities. According to the survey results, these facilities collectively processed 1.5 million tons of inert waste. This accounted for about 0.4% of the annual production of aggregates in France and represented a significant 10% of the production of recycled aggregates originating from demolition activities [ADEME, 2011].

Table 28. Inert and non inert-non hazardous CDW data based on a 2009 survey by ADEME on 39 CDW sorting/recovery facilities (Deloitte, 2015).

	Operators	Average quantity of CDW treated by platform (Kt)	Recovery rate	Type of recovery	Average geographical area (ha)	Average number of workers	Turnover (M€)	CAPEX (M€)	OPEX (€/t)
Mechanised sorting line + Inert and NINH CDW recovery	Waste management professionals	70 Kt	70%	Mainly material recovery, only 2% of energy recovery	9 ha	15	0.5 to 2 M€	2.1 M€	NC
Simple sorting + Inert and NINH CDW recovery	65% building firms 35% waste management professionals	35 Kt	55%	Mainly material recovery	3 ha	10	0.5 to 2 M€	1.2 M€	25 €/t
Mechanised sorting line + Inert CDW recovery	Quarries	180 Kt	85%	Only material recovery	5 ha	10	2 M€	2.9 M€	NC
Simple sorting + Inert CDW recovery	Mainly building firms	80 Kt	75%	Only material recovery	4 ha	3	0.8 M€	1 M€	6 €/t

In 2010, out of the 251 million tons of inert waste produced (not only by building and public works), 49% were used for road filling, 16% recovered by other means and 35% landfilled (Deloitte, 2015).

Extractive industry

In 2016, the extractive industry in France played a significant role in supplying the construction sector with natural sands and aggregates. This sector demonstrated a robust performance, contributing to the country's economy. The key highlights of the extractive industry's activities in 2016 are as follows:

1. Turnover and Company Landscape: The extractive industry achieved a notable turnover of 3,448 million euros (excluding VAT) during this period. This industry was composed of a considerable number of players, with 1,565 companies actively engaged in extraction activities. These companies operated at a total of 2,730 extraction sites, comprising approximately 2,300 pits and quarries, as well as around 400 recycling plants.
2. Natural Sands and Aggregates Extraction: The core activity of the extractive industry in France was the extraction of natural sands and aggregates. A substantial volume of 304.4 million tons of these materials was extracted during the year. This impressive production rate amounted to an annual average of 4.5 million tons of natural sands and aggregates extracted per inhabitant in the country.
3. Recycled Sands and Aggregates Production: Alongside natural materials, the industry also contributed to recycling efforts. In 2016, a significant volume of 25.7 million tons of recycled sands and aggregates was produced. Out of this total, 21.4 million tons were derived from the construction and demolition sector, reflecting the sector's commitment to recycling practices. It's important to note that a considerable quantity of sands and aggregates were also recycled on-site.
4. Total Sands and Aggregates Production: When considering both natural and recycled materials, the total volume of sands and aggregates produced in France in 2016 reached an estimated 376 million tons. This comprehensive production included materials used in various construction applications.
5. Production Trends: The production trends of sands and aggregates in France were illustrated through Figure 28, which indicated an overall decrease in production over the past decade. This decline in production was observed despite the significant efforts in recycling and extraction. The industry faced challenges and shifts in demand during this period, contributing to this trend [UNPG, 2018].

The extractive industry's performance in 2016 highlights its critical role in supplying essential construction materials to support infrastructure and building projects across France. While the production of natural sands and aggregates remained substantial, recycling efforts demonstrated the sector's commitment to sustainability and responsible resource management. However, the industry also faced ongoing challenges, including changing demand dynamics, which influenced production trends over the years [UNPG, 2018].

Production nationale de granulats

(en millions de tonnes)	2015	2016	% 2016/15	Structure en %
Roches meubles	117,9	120,4	+ 2,1	39,6
Alluvionnaires	94,2	96,0	+ 1,9	31,5
Granulats marins	6,5	6,0	- 7,7*	2,0
Autres sables	17,2	18,4	+ 7,0	6,0
Roches massives	184,4	184,0	- 0,2	60,4
Roches calcaires	90,5	90,8	+ 0,3	29,9
Roches éruptives	93,9	93,2	- 0,7	30,5
Granulats naturels	302,3	304,4	+ 0,7	100
Granulats de recyclage	25,3	25,7	+ 1,6	
Issus de démolition (1)	20,9	21,4	+ 2,4	
Artificiels**	4,4	4,3	- 2,3	
TOTAL	327,6	330,1	+ 0,8	

(1) Granulats de recyclage produits sur carrières ou installations dédiées, c'est-à-dire hors recyclage directement sur chantiers

* Cette variation est à apprécier avec prudence car la méthodologie de collecte de données a été modifiée en 2016

** Laitiers, schistes et granulats issus des MIDND (mâchefers d'incinération de déchets non dangereux)

Figure 27. National production of sands and aggregates in 2015 and 2016 (UNPG, 2018).

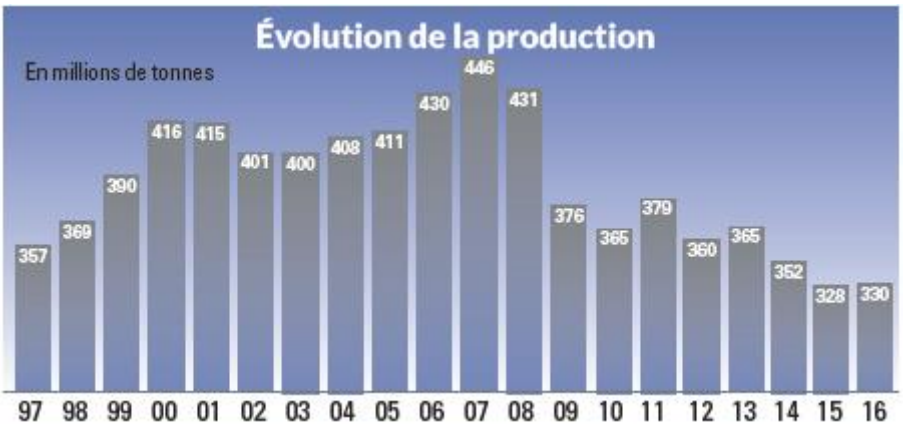


Figure 28. Evolution of the production of sands and aggregates in France since 1997 (including recycled and manufactured materials) (UNPG, 2018).

In 2016, the production of sands and aggregates in France exhibited regional variations, with specific areas emerging as key contributors to the industry. Here are the key insights into regional production and recycling patterns:

Production of Sands and Aggregates by Region:

1. South and West Regions: The southern and western parts of France were significant contributors to the production of sands and aggregates. Notable regions in this category included Auvergne-Rhône-Alpes, Nouvelle-Aquitaine, Grand Est, Occitanie, and Pays de la Loire. These regions collectively produced substantial quantities of these essential construction materials, with millions of tons being extracted in each area.

2. Main Production Regions: Among the regions mentioned above, Auvergne-Rhône-Alpes stood out as a major production hub, contributing 46.3 million tons of sands and aggregates. Other regions, including Nouvelle-Aquitaine, Grand Est, Occitanie, and Pays de la Loire, also played significant roles in meeting the demand for these materials.

Recycling of Sands and Aggregates by Region:

1. North-Eastern Regions: In contrast to the main production regions, the recycling of sands and aggregates was more concentrated in north-eastern France. Regions like Ile-de-France, Grand Est, and Hauts-de-France emerged as primary hubs for recycling these materials. These areas were particularly active in recycling aggregates and sands from demolition sources.
2. Ile-de-France: The Ile-de-France region, which includes Paris and its surrounding areas, was a central player in the recycling of aggregates and sands. It served as a major contributor to the overall recycled materials production in France.
3. Auvergne-Rhône-Alpes: While known for its production, the Auvergne-Rhône-Alpes region also played a significant role in recycling activities. It contributed 3.8 million tons of recycled products in 2016, indicating its commitment to sustainable practices.

On-Site Recycling: It's worth noting that the figures provided in Figure 27 did not account for the significant quantity of sands and aggregates that were recycled on-site. On-site recycling is a common practice in construction projects, further adding to the sustainability of the industry.

In summary, the production and recycling of sands and aggregates in France exhibited regional disparities, with southern and western regions being major production centers and north-eastern regions leading in recycling efforts. These regional variations reflected the diverse construction and infrastructure needs across the country. Additionally, on-site recycling played a crucial role in contributing to the overall sustainability of the construction sector [UNPG, 2018].

Productions régionales de granulats

(en millions de tonnes)	Roches meubles	Roches massives	Granulats de recyclage	Total	% 2016/ 2015
AUVERGNE-RHÔNE-ALPES	**24,4**	**18,1**	**3,8**	**46,3**	**1,8%**
RHÔNE-ALPES	22,5	10,9	3,5	36,9	3,4%
AUVERGNE	1,9	7,2	0,3	9,4	-5,1%
NOUVELLE-AQUITAINE	**14,4**	**23,6**	**1,2**	**39,2**	**-6,6%**
AQUITAINE	10,1	6,9	1,0	18,0	-5,3%
POITOU-CHARENTES	4,1	13,2	0,2	17,5	-10,3%
LIMOUSIN	0,2	3,5	0,0	3,7	12,1%
GRAND EST	**22,4**	**11,8**	**4,3**	**38,5**	**5,8%**
ALSACE	14,5	0,5	2,3	17,3	6,8%
LORRAINE	3,8	5,9	1,8	11,5	7,5%
CHAMPAGNE	4,1	5,4	0,2	9,7	1,0%
OCCITANIE	**12,9**	**22,0**	**1,8**	**36,7**	**-2,7%**
MIDI-PYRÉNÉES	10,7	8,8	0,7	20,2	2,5%
LANGUEDOC	2,2	13,2	1,1	16,5	-7,8%
PAYS DE LA LOIRE	**8,6**	**23,5**	**0,5**	**32,6**	**0,0%**
PROVENCE	**5,7**	**15,0**	**3,4**	**24,1**	**-1,6%**
BRETAGNE	**1,6**	**21,0**	**0,2**	**22,8**	**-2,6%**
BOURGOGNE FRANCHE-COMTÉ	**3,7**	**18,3**	**0,3**	**22,3**	**5,7%**
BOURGOGNE	2,5	8,7	0,2	11,4	3,6%
FRANCHE-COMTÉ	1,2	9,6	0,1	10,9	7,9%
HAUTS-DE-FRANCE	**5,2**	**12,2**	**3,7**	**21,1**	**6,0%**
NORD	1,2	11,7	3,0	15,9	8,9%
PICARDIE	4,0	0,5	0,7	5,2	-1,9%
NORMANDIE	**9,1**	**10,3**	**1,1**	**20,5**	**6,8%**
BASSE-NORMANDIE	1,6	10,2	0,3	12,1	4,3%
HAUTE-NORMANDIE	7,5	0,1	0,8	8,4	12,0%
ILE-DE-FRANCE	**6,6**	**1,6**	**4,8**	**13,0**	**3,2%**
CENTRE-VAL DE LOIRE	**4,8**	**5,6**	**0,6**	**11,0**	**1,9%**
CORSE	**1,0**	**1,0**	**0**	**2,0**	**-4,8%**
TOTAL	**120,4**	**184,0**	**25,7**	**330,1**	

Figure 29. Regional production of sands and aggregates in 2016 (in million tons) (UNPG, 2018).

In 2016, the sands and aggregates industry in France exhibited a significant balance between exports and imports, while also highlighting their various applications within the domestic market. Here are the key points regarding the trade and consumption of sands and aggregates:

Trade of Sands and Aggregates:

1. Exports: France was a net exporter of sands and aggregates in 2016, with approximately 9 million tons of these materials being shipped to neighboring countries such as Switzerland, Germany, the Netherlands, Belgium, and the UK. This export activity reflected the competitiveness and quality of French sands and aggregates on the international market.
2. Imports: Simultaneously, France imported around 10.7 million tons of sands and aggregates from countries like Belgium, Spain, Germany, the UK, and Norway.

These imports might have included specific types of sands and aggregates not readily available domestically or were sourced for specialized construction projects.

Applications of Sands and Aggregates:

1. Roads, Railways, and Containment Works: A significant portion of sands and aggregates, accounting for 57%, was dedicated to road construction, railway projects, and containment works. These materials are essential for building and maintaining transportation infrastructure and structures such as retaining walls.
2. Concrete Production: Sands and aggregates were also utilized in the production of concrete elements, albeit to a lesser extent. Only 5% of the sands and aggregates were directed towards this application. Concrete elements are used in various construction projects, including buildings and infrastructure.

Consumption of Sands and Aggregates in the French Market:

1. Total Consumption: The French market's consumption of sands and aggregates in 2014 amounted to a substantial 423 million tons. This indicated the significant demand for these materials in construction and infrastructure development.
2. Recycled Materials: Approximately 23.1% of the sands and aggregates consumed were sourced from recycling, either on-site or in sorting-recycling plants. This percentage reflected the growing emphasis on sustainability and the use of recycled materials in construction projects.
3. Natural Origin: The majority of the sands and aggregates used in France, ranging between 70% and 75%, were of natural origin. This highlighted the reliance on primary resources to meet the country's construction needs.

In conclusion, France maintained a healthy balance between exports and imports of sands and aggregates in 2016, demonstrating the competitiveness of its materials on the global stage. These materials found applications in a wide range of construction and infrastructure projects, with a notable emphasis on road and railway construction. Additionally, the use of recycled materials in the French market highlighted the country's commitment to sustainability in the construction sector [UNPG, 2018].

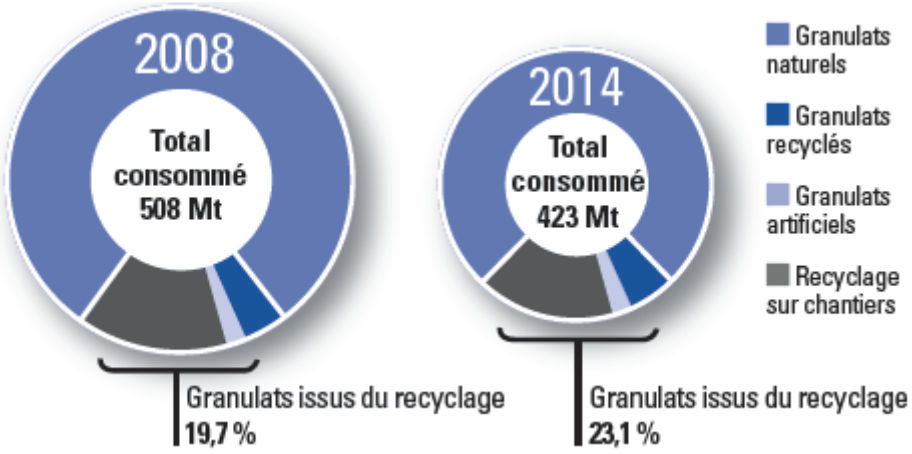


Figure 30. Consumption of sands and aggregates in France (UNPG, 2018).

Conclusion

In France, concrete production and utilization, along with the management of construction and demolition waste (CDW), are integral to the construction industry and sustainability endeavors. Key insights and statistics include:

The country produces 19 million tons of concrete for prefabricated elements, with blocks accounting for half of this concrete usage. Additionally, France manufactures 36.3 million cubic meters (around 90 million tons) of ready-mixed concrete, significantly surpassing the concrete used for prefabricated elements. Prefabricated concrete elements represent less than 20% of the total concrete production in France, which is below the European average.

Regarding CDW generation, France annually generates an estimated 230-240 million tons of inert CDW, with a substantial portion, approximately 70%, consisting of unpolluted soils and stones mainly originating from earthmoving and demolition activities. Of the inert CDW produced, roughly 70 million tons comprise mixed and unmixed Concrete-Based Total Cadre de Terrassement et de Construction (CBTC), including materials like concrete debris.

France produces approximately 21 million tons of recycled sands and aggregates each year from demolition sources, accounting for about 6% of the total production of sands and aggregates in the country. These recycled materials are manufactured in 400 CDW recycling plants, with regions in the northeastern part of France being particularly productive in recycling efforts. Additionally, there is a significant quantity of on-site recycled inert waste, estimated to be between 40 to 50 million tons annually. When combined with off-site recycling, the total production of recycled materials accounts for 20% of the total production of sands and aggregates.

Landfilling of inert CDW is significant, with around 80 million tons of inert wastes landfilled in France in 2012, representing approximately 35% of the total inert wastes generated. France has 657 Class 3 landfills (installations de stockage de déchets inertes or ISDI) for inert wastes, outnumbering CDW recycling plants. Low taxes applied to inert CDW contribute to the economic feasibility of landfilling, potentially discouraging recycling efforts.

The extractive industry in France had a turnover of 3,448 million euros in 2016, with 1,565 companies operating approximately 2,300 pits, quarries, and 400 recycling plants. The industry extracts around 304.4 million tons of natural sands and aggregates annually, equating to approximately 4.5 million tons per inhabitant.

The main regions for natural sands and aggregates production are predominantly in the southern and western parts of the country, including Auvergne-Rhône-Alpes, Nouvelle-Aquitaine, Grand Est, Occitanie, and Pays de la Loire.

In terms of utilization, France exported 9 million tons of sands and aggregates to neighboring countries in 2016 while importing 10.7 million tons. These materials primarily find use in road construction, railway projects, and containment works, with only 5% utilized in concrete production.

Market consumption of sands and aggregates in France reached approximately 423 million tons in 2014, with a notable 23.1% sourced from recycling, either on-site or in recycling plants. Balancing resources, managing CDW effectively, and promoting

sustainability are crucial challenges and opportunities for France's construction sector [UNPG, 2018].

Drivers and barriers needed to increase CDW recycling in France are developed in Table 29.

Table 29. Drivers and barriers to increase CDW recycling in Germany (Deloitte, 2015).

Factor / characteristic / element in CDW recycling chain	Drivers	Barriers
Legislation and regulation	• Implementation of national and departmental CDW management plans • Compulsory pre-audits on demolition sites • Objective of stabilising by 2020 the production of CDW at the level reached in 2010 (260 Mt), set by the 2014-2020 Waste prevention plan • Inert waste storage facilities becoming establishments classified for environmental protection (ICPE) as of 1st January 2015. • EoW status and criteria defined by law.	• The use of recycled materials from CDW is not sufficiently supported through public procurement. • There is still no departmental CDW management plan in force as of today. • Contractors must demonstrate that it is technically possible to use construction materials from recycling. • Backfilling and ground raisings are not sufficiently regulated in the Town planning Code: ground raisings of a height less than 2 meters (or depth for backfilling) or which total area is lower than 100 m^2 are exempted of any formality.
Resources allocated to CDW prevention and management	• Total ADEME intervention budget on waste matters amounted 943 M€ for the period 2009-2013, of which 222Me were dedicated to prevention.	• According to all interviewed stakeholders the human and financial resources allocated to CDW legislation enforcement are not sufficient. • Sanctions are reported to be too low and rarely applied. • Quarries departmental schemes should be grouped into regional schemes and better integrate recycling issues.
Treatment facilities territorial network		• Almost all stakeholders pointed out that there are currently not enough treatment installations, the existing ones being therefore too far from the sites, which encourages dumping. • It appears that local authorities are most often reluctant to authorize the installation

		of new treatment facilities.
Market conditions	• Landfill tax (TGAP) is a powerful recovery/recycling improvement tool.	• A majority of construction companies declare that operating costs of CDW sorting, recovery and recycling are too high. • The Landfill tax (TGAP) is low compared to other MS, which does not encourage building firms to favour recycling and recovery over landfill.
Definitions and statistical data	• Set separate objectives for inert waste and non-inert non-hazardous waste (NINH) recycling, in order not to mask NINH CDW recycling performance behind the one of inert waste (80% of non-hazardous CDW excluding soil). • Harmonise the statistical recording rules of backfilling operations (see right-hand column) • Use Construction Regional Economic Cells (CERC) data as a basis for national statistics • Several stakeholders also pointed out that inert, non-hazardous and hazardous waste categories should be harmonised between all Member States so as to enable comparisons. For instance glass wool wastes are considered as non-hazardous in France while they are hazardous wastes in Germany.	• It is very difficult to assess precisely CDW sources and streams. • With the current definitions it is theoretically possible to reach the objective of 70% CDW recovery and recycling only by backfilling quarries with inert waste • If the backfilling of a quarry is anticipated in the prefectoral operating order, then the corresponding CDW will be recorded as backfilling and integrated in recovery statistics; whereas if the backfilling is performed in the framework of an ISDI it will be recorded as landfill. • Running national surveys every 4 or 6 years is very time consuming for the construction companies and it is useless to monitor CDW recycling performances at local level, which is the only relevant one since 90% of the CDW loads travel less than 50 km.
Works contracts	• Extend the practice of allotment in order to secure the budget and time allocated to waste management.	• Waste management being only one element amongst others in works contracts, it is often neglected. • Upstream studies on waste management planning and pre-audits on demolition sites are rarely performed. • Lack of traceability and control of the recycling rate on which the winner of the call for tender commited himself.
Recycling process and techniques	• Systematizing buildings ecoconception would be a major driver to easing end-of-life deconstruction and recycling • Many innovative companies and R&D programmes	• Lack of space on building sites • Most often demolished buildings were not conceived as to be easily deconstructed and recycled. • There are only 15 mechanised sorting lines in the whole country.

I.4 3.2.4. Germany

Construction sector data

The construction sector in Germany plays a significant role in the national economy, contributing 4.8% to the country's gross value added. In 2014, the German construction industry achieved a turnover of 99.4 billion Euros. This robust performance is reflected in Figure 32, which illustrates the turnover in the German construction sector from 1995 to 2014, showing consistent growth over the years.

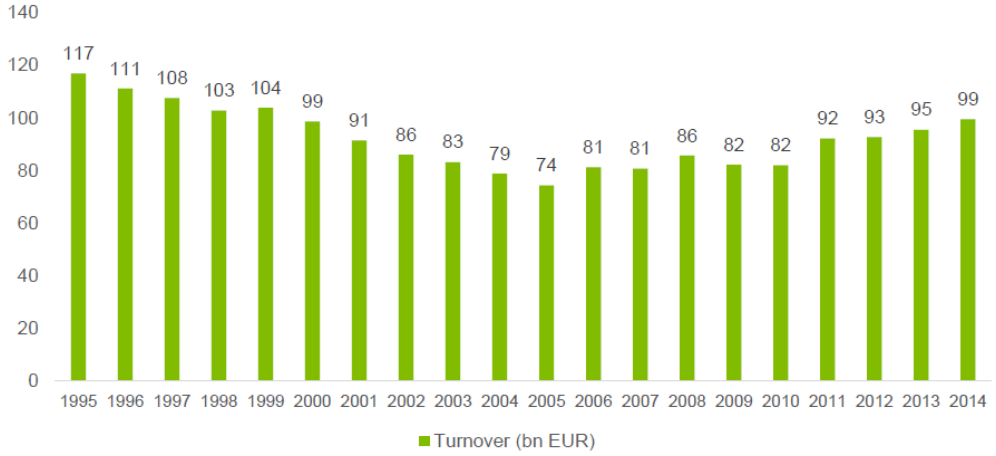


Figure 31. Turnover of the German construction sector since 1995 (Deloitte, 2015).

he cement demand in Germany is primarily directed towards the production of in-situ concrete, accounting for 55.4% of cement usage. Within this category, ready-mixed concrete constitutes nearly 92%, with the remaining 8% being site-mixed concrete. Precast concrete components also hold significant importance, representing approximately 28.9% of cement demand. The German Ready-Mixed Concrete Association reports a total production volume of 49.4 million cubic meters of ready-mixed concrete, with corresponding sales of €3.32 billion in 2016. This data allows us to estimate that the total concrete production (including ready-mixed concrete and prefabricated concrete elements) in Germany reached 75 million cubic meters in 2016. This translates to an annual production of 0.9 cubic meters of concrete per inhabitant.

The generation of construction and demolition waste (CDW), including roadbreaking, amounted to 209 million tons in Germany in 2015. The evolution of CDW production between 2000 and 2015 is depicted in Figure 32, where the yellow columns represent the changes over the years.

Concrete, bricks, tiles, and ceramics (CBTC) constitute a substantial portion of CDW in Germany, making up approximately 27% of the total CDW, as shown in Figure 33 and Figure 34. In 2017, this corresponds to roughly 54.6 million tons of CBTC generated within the country [Deloitte, 2015].

Production of wastes

Figure 32 illustrates the production of construction and demolition waste (CDW), including roadbreaking, in Germany. In 2015, the country generated a total of 209 million tons of CDW. The yellow columns within the diagram provide a visual representation of how CDW production has evolved between the years 2000 and 2015, highlighting the significant quantities of waste generated in this sector over the years.

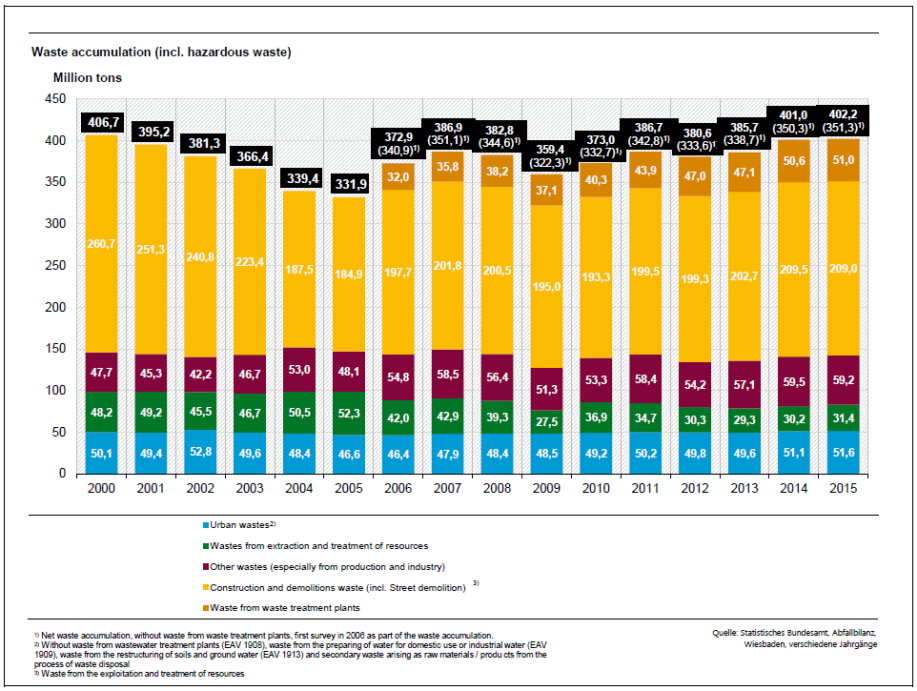


Figure 32. Evolution of the production of wastes in Germany between 2000 and 2015.

CBTC (Concrete, bricks, tiles, and ceramics) accounts for approximately 27% of the total amount of construction and demolition waste (CDW) generated in Germany, as indicated in Figure 33 and Figure 34. In 2017, this proportion translated to roughly 54.6 million tons of CBTC waste, underlining the significant volume of these materials within the overall CDW stream.

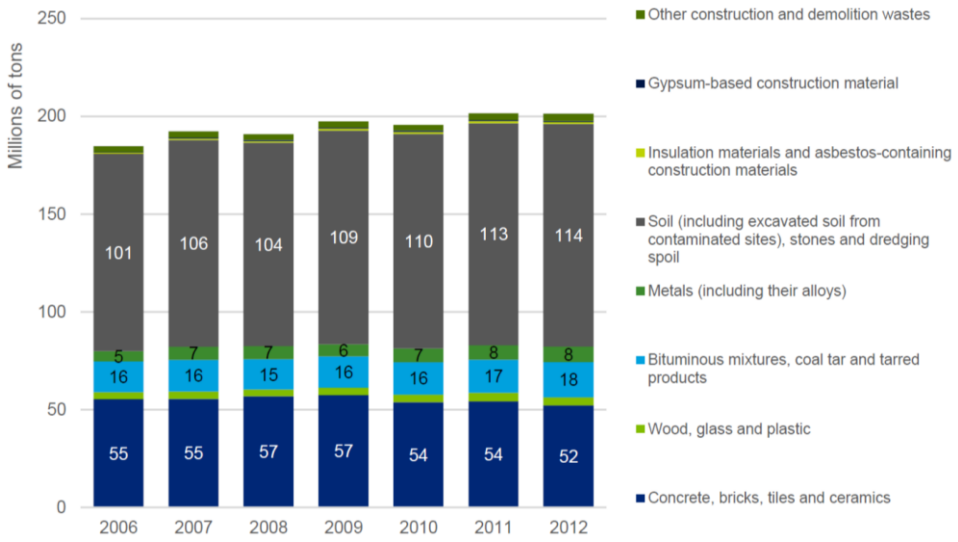


Figure 33. Evolution of the production of CDW in Germany between 2006 and 2012 (from Deloitte, 2015).

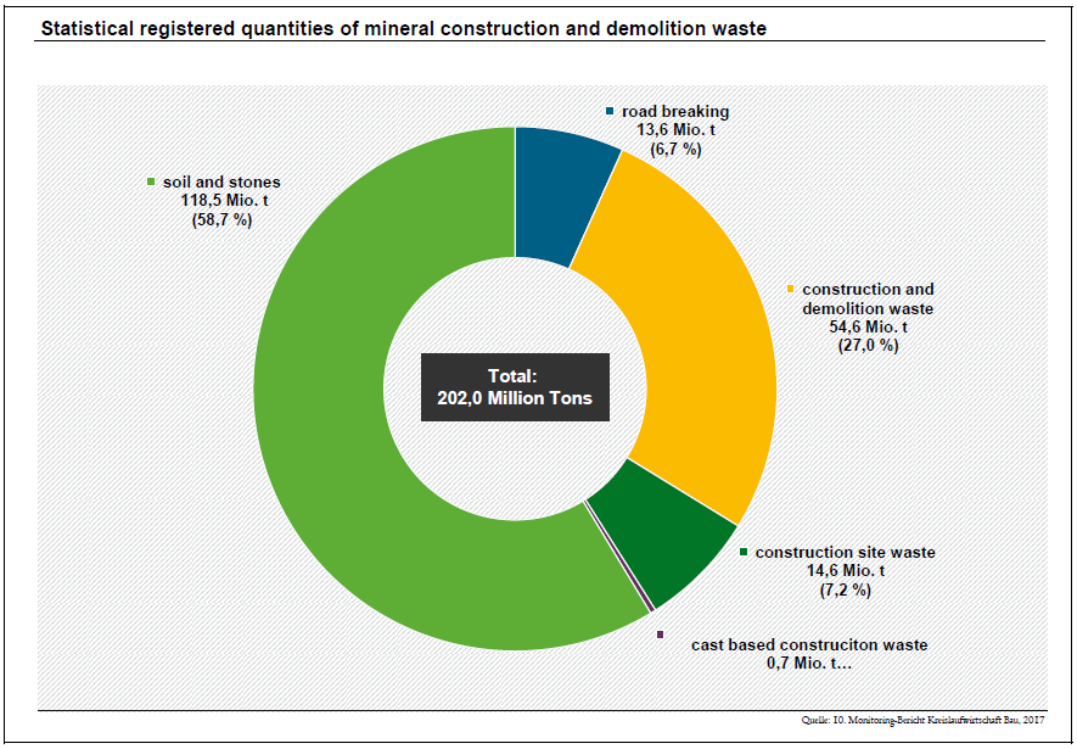


Figure 34. Proportion of the different components of CDW produced in Germany in 2017.

Production of recycled aggregates and sands

In 2012, Germany produced approximately 66.2 million tons of recycled construction and demolition waste (CDW), as illustrated in Figure 35. This included various recycled materials such as sands and aggregates, contributing to 13% of the total demand for aggregates in Germany.

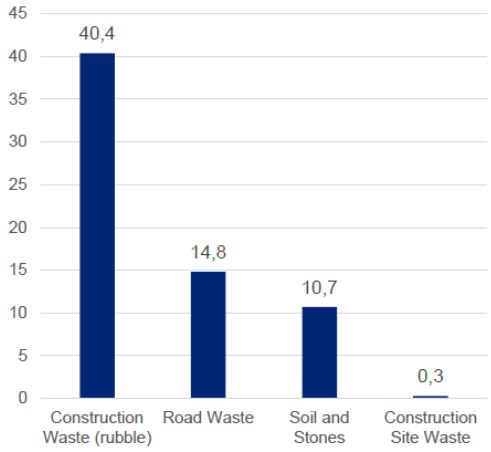


Figure 35. Production of recycled CDW (Deloitte, 2015).

Germany had a total of 2,073 CDW treatment facilities in 2010, with Bavaria hosting 30% of these facilities, as depicted in Figure 36. These treatment facilities collectively processed 62.5 million tons of CDW with a combined capacity of 107 million tons in the same year, as shown in Figure 37. Interestingly, while Bavaria had the highest number of treatment facilities, the largest inputs and capacities were concentrated in North Rhine-

Westphalia. Several states maintained spare capacities, while others operated with significant overcapacities.

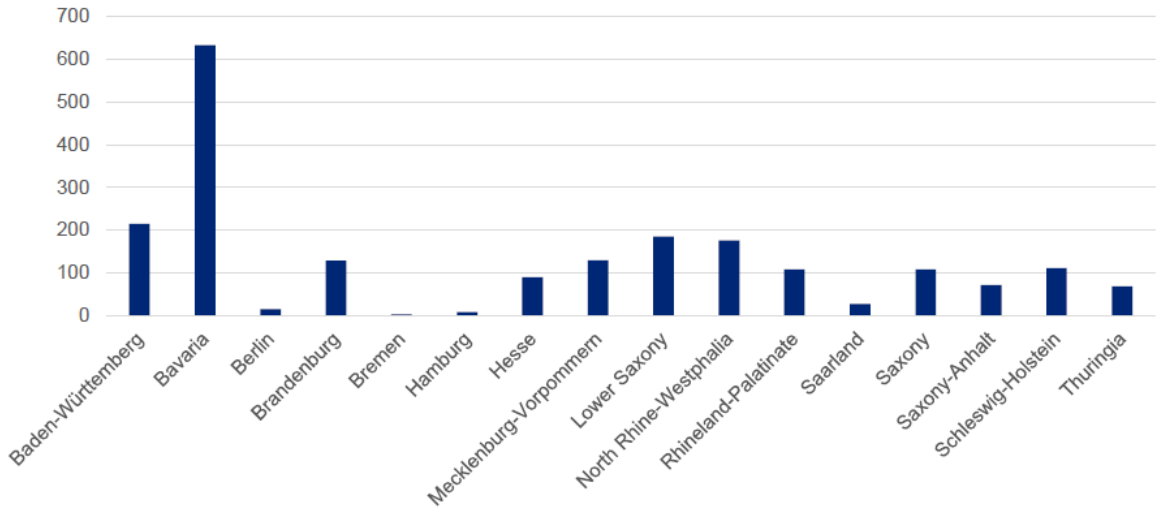


Figure 36. Number of CDW recycling plants par state in Germany in 2010 (Deloitte, 2015).

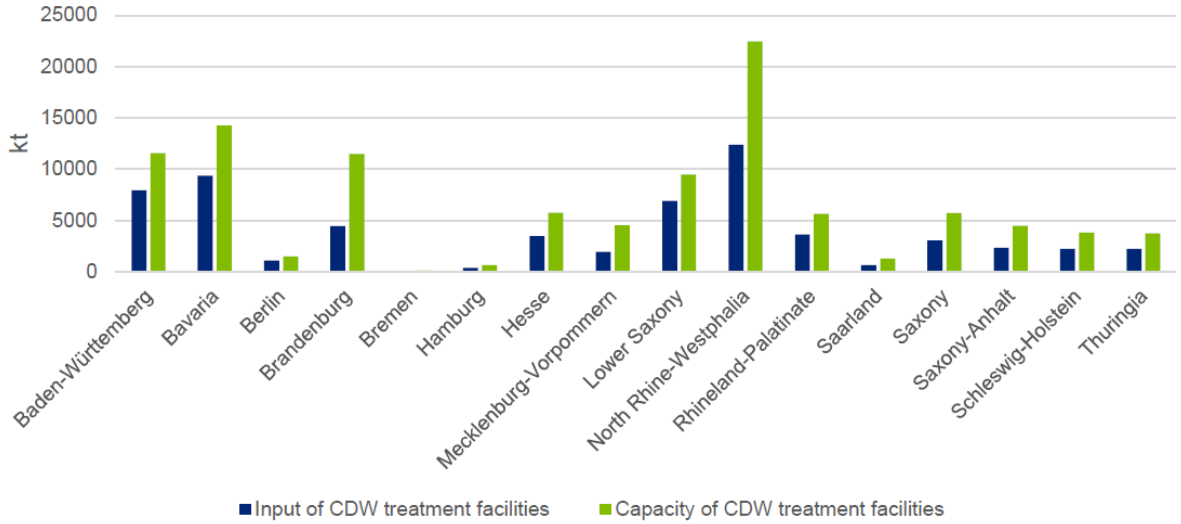


Figure 37. Input and capacity of CDW recycling plants in Germany in 2010 (in kt) (Deloitte, 2015).

In 2014, Germany recycled a total of 67.6 million tons of building materials, with 20.7% (approximately 14 million tons) allocated for use in the production of concrete and asphalt, as highlighted in Figure 38. These recycled materials found applications in various construction activities, both from mobile and stationary recycling plants, including backfilling, construction pits, anti-noise barriers, embankments, subconstruction, foundation ground improvement, and qualified road construction, among others. Additionally, recycled materials were employed in concrete production.

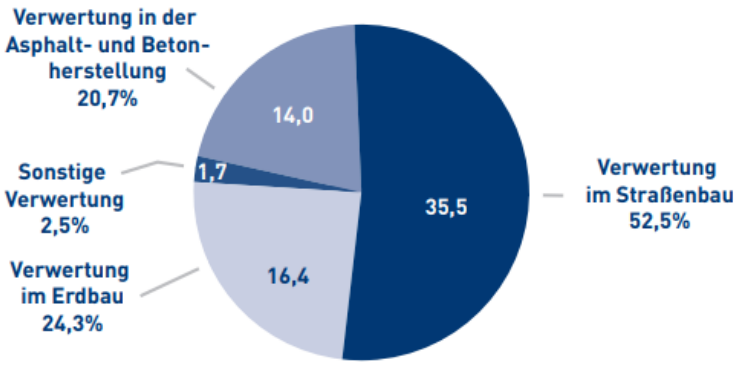


Figure 38. Recovery of recycled aggregates and sands in Germany in 2014.

Recovered recycled aggregates and sands in Germany are utilized in various applications, including:

a) Recycled Aggregates from Mobile Plants:

- Backfilling and cover filling
- Backfilling for construction pits
- Anti-noise barriers and embankments
- Subconstruction
- Foundation ground improvement

b) Recycled Aggregates from Stationary Plants:

- Recycled construction material for qualified road construction
- Recycled material for concrete production

These applications contribute to sustainable construction practices by reusing materials from construction and demolition waste, reducing the demand for new resources, and promoting environmentally responsible construction methods.

Landfilling

In Germany, the disposal of construction and demolition waste (CDW) through landfilling has significantly reduced in recent years. Excluding soil and stones, less than 5% of CDW has been landfilled annually since 2010. This accounts for approximately 3-4 million tons of CDW that are landfilled each year (Deloitte, 2015).

The CDW that is landfilled serves various purposes, including landfill cover and material for road construction. Soil and stones, in particular, are commonly used for backfilling and landfill cover applications. However, it's important to note that Germany's landfill capacity is limited, and according to the 'Umweltbundesamt,' the country's current landfill capacity is projected to be exhausted in approximately two decades.

Landfill Class 0, which pertains to inert wastes, is the most prevalent type of landfill in Germany, with nearly 800 landfills distributed throughout the country (Table 30). The total number of landfills has been steadily descreasing between 2005 and 2015 (Table 31). This trend is in alignment with the principles of the Circular Economy Act, where disposal is considered the last resort in waste management practices.

Table 30. Number of landfills in Germany in 2015[5].

Type of landfill	**Number of landfill**
Landfills (Class 0) for Inert Waste	787
Landfills (Class 1) for Mineral Waste	138
Landfills (Class 2) for Municipal Waste	154
Landfills (Class 3) for Hazardous Waste	27
Subsurface Landfills (Class 4)	4

Table 31. Number of Landfills in Germany between 2005 and 2015[6].

Year	**Number of Landfills**
2005	1.948
2006	1.740
2007	1.706
2008	1.645
2009	1.553
2010	1.186
2011	1.180
2012	1.146
2013	1.142
2014	1.131
2015	1.110

In 2012, a significant portion of the waste from category 17, which includes Construction and Demolition Waste (CDW) along with soil and stones, was managed in landfills. Out of a total of 1,146 landfills, 948 of them, constituting 83%, received a combined input of 19.8 million tons of waste falling into this category (Deloitte, 2015).

The distribution of this waste within different landfill classes was as follows:

- Approximately 56% of the waste ended up in Class 0 landfills, which are designated for inert waste.

[5] Statistisches Bundesamt - Abfallentsorgung 2015
[6] Statistisches Bundesamt - Abfallentsorgung 2015

- Another 23% was directed to Class 1 landfills, designed for mineral waste.
- The remaining 19% was allocated to Class 2 or 3 categories, which include Municipal Waste and Hazardous Waste (see Figure 39).

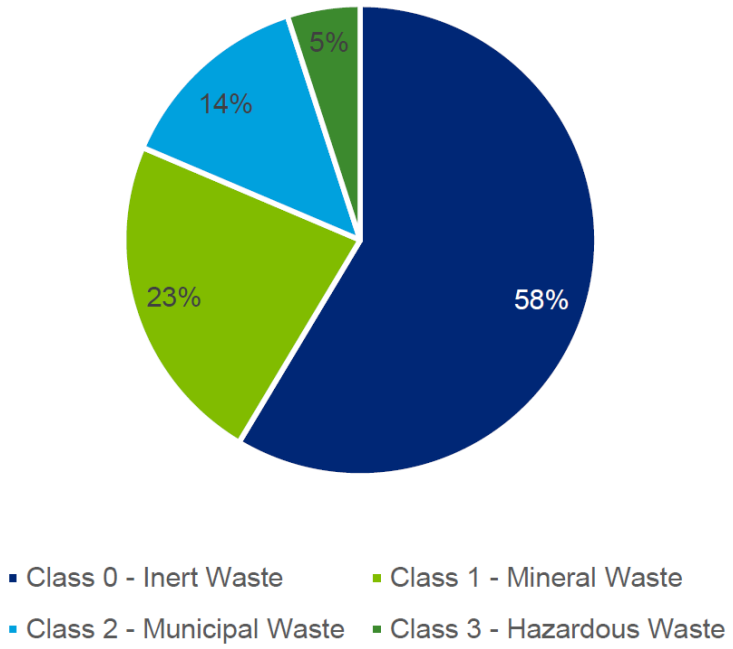


Figure 39. Repartition of landfill classes for category 17 of the List of Waste in 2012 (Deloitte, 2015).

The tax rates for landfilling in Germany vary depending on the type of waste and are subject to regional differences. An illustrative example of landfill tax rates is provided for Ortenaukreis, a district located in the western part of Baden-Württemberg, Germany. The specific tax rates for different waste types in Ortenaukreis can be found in Table 32.

Table 32. Taxes for landfilling applied in Ortenaukreis (west of Baden-Württemberg, Germany).

Waste type	**Tax since January 01.2017**
Not recyclable mineral waste (e.g. inapplicable construction waste, gypsum waste, etc.) As well as contaminated excavated soil as far as this is storable according to previous check on a landfill class II	71 EUR/t
Excavated soil, delivered on a landfill	6 EUR/m^3
Recyclable construction waste, delivered on a landfill	14 EUR/m^3

Extractive industry

Germany stands as the largest producer of aggregates in Europe, contributing significantly to the region's supply of natural sands and aggregates. In 2010, Germany produced 413 million tons of sand, gravel, and crushed natural stones, as shown in Table 33. The country's aggregates industry encompasses around 1,600 companies, operating approximately 3,200 plants and employing 27,000 workers. These companies primarily serve contractors and construction materials producers.

Table 33. Production of primary raw materials in Germany between 2000 and 2010 (Kaumanns & Lauber, 2016).

Raw Material	**Year**	**Amount produced (million tons)**
Sand, gravel, crushed natural stones	2000	572
	2008	449
	2009	427
	2010	413

According to MIRO (Mineralische Rohstoffe), Germany's Aggregates Federation, the nation possesses substantial reserves of mineral raw materials. In the construction sector, Germany's domestic reserves are ample, reducing the need for material imports. The annual demand for gravel, sand, silica sand, and natural stone products in Germany is estimated to reach 500 million tonnes.

Table 34 provides a price list for crushed primary aggregates and sands in Germany, reflecting prices as of April 2018. From an economic perspective, primary resources used in construction are not considered scarce enough to make recycled resources a more attractive alternative.

Table 34. Price list for crushed primary aggregates and sands in Germany applied in April 2018 (Baustoffe liefern[7]).

Material	**Unit**	**Price in €/Unit (incl. VAT)**
Basalt – broken sand 0-5mm	t	19,99
Basalt gravel 0-32	t	28,32
Basalt gravel 0-32 mm	t	14,90
Basalt gravel 0-45 mm	t	19,60
Basalt gravel 16-32 mm	t	29,70

[7] http://www.baustoffe-liefern.de/Schotter/Preisliste-Schotter.html

Basalt crushed stones 11-16 mm	t	60,00
Granite gravel 32/56 mm	t	145,00
Granulated gravel 0-5 mm	t	21,42
Rough gravel	m^3	28,00
Limestone gravel 0-16	m^3	20,00
Limestone gravel 0-32	m^3	18,00
Limestone gravel 0-45	m^3	28,44
Limestone gravel 0-56	m^3	16,00
Limestone gravel 16-32	m^3	20,00
Limestone gravel 5-45	m^3	33,56
Limestone gravel 0-45 mm	t	17,50
Limestone gravel mix 0-32 (KFT or mineral concrete)	t	6,70
Limestone gravel mix 0-45 (KFT or mineral concrete)	t	16,70
Limestone gravel 0-45 mm	t	17,50
Limestone gravel mix 0-32 (KFT or mineral concrete)	t	6,70
Limestone gravel mix 0-45 (KFT or mineral concrete)	t	16,70
gravel 0-22	m^3	45,30
gravel 0-45	m^3	38,10
gravel 0-45mm	t	20,08
gravel 0/ 45	m^3	30,00
gravel 16/32	t	79,30
gravel 16/32 mm	t	23,99
gravel 32/56 mm	t	23,99
gravel 45/80	t	19,00

gravel 5/ 45	m^3	32,00
gravel 8-16, 16-32, 32-56	t	11,50
gravel 8/16	t	79,30

Conclusion

In Germany, the production of ready-mixed concrete significantly outweighs the production of prefabricated concrete elements, with ready-mixed concrete production reaching nearly 50 million m^3 annually. Within the construction sector, ready-mixed concrete constitutes a substantial portion of the market. Additionally, concrete, bricks, tiles, and ceramics (CBTC) make up around 27% of the total construction and demolition waste (CDW), equivalent to 54.6 million tons out of a total of 209 million tons of CDW in 2017.

The recycling of CDW is well-established in Germany, with over 2,000 recycling plants distributed across the country. Bavaria is a prominent state in this regard, hosting 30% of these recycling facilities. North Rhine-Westphalia, on the other hand, is the leading state in terms of recycled aggregates and sands production, with 21% (14 million tons) of these recycled materials used for concrete and asphalt applications.

In the broader context of aggregates production, Germany stands as the largest producer in Europe, contributing over 15% of the total production of sands and aggregates among its 30 European member countries. The annual demand for natural sands and aggregates in Germany is estimated at 500 million tons.

Despite the availability and well-developed infrastructure for CDW recycling, there are challenges related to the reputation and cost of CDW products. Constructors often have quality concerns, and recycled CDW products may not always be significantly cheaper than primary resources, depending on market conditions and geographic factors (Deloitte, 2015).

Drivers and barriers needed to increase CDW recycling in Germany are developed in Table 35.

Table 35. Drivers and barriers to increase CDW recycling in Germany (Deloitte, 2015).

Factor / characteristic / element in CDW recycling chain	Drivers	Barriers
Legislation and regulation		The lack of a nationwide regulation for secondary building materials resulted in various different legislations at state level which are difficult to overlook and to adapt to. This should be overcome with the national legal framework for ground water, substitute building materials, landfill and soil protection (Mantelverordnung) which is under development since 2006.
Resources allocated to CDW legislation enforcement		According to stakeholders, the human resources allocated to law enforcement, which happens most of the time at the local level, are insufficient. Sanctions are reported to be too low and rarely applied.
Market conditions		Primary raw materials are abundant in most of the regions in Germany and therefore cheap when compared to recycled materials, which can sometimes be even more expensive. Since no subsidies or other economic incentives exist that could drive the use of secondary materials, the choice to opt for primary materials is most of the time price related.
Norms	DIN and EN norms do not constitute any barriers for CDW recycling and could act as drivers (e.g. to be pointed out for public tenders)	
Public Tenders	Public tenders that value recycled materials at least the same way as primary raw materials or even explicitly favour the use of recycled construction materials. This is happening in some regional projects, but would need to be further elaborated in the future.	
Information provision and education	Today, it is still the case that recycled materials are perceived to have a lower quality as comparable primary materials and constructors want to minimize their risk. More scientifically proven information, quality control and education can drive the increased use of recycled materials and create a demand. Such projects with an education character already exist but would need to be further elaborated.	
Labelling	Certificates are an important driver. E.g. the DGNB assesses buildings and urban districts which demonstrate an outstanding commitment to meeting sustainability objectives.	

CONCLUSIONS

In conclusion, France, Germany, Belgium, and the Netherlands showcase diverse approaches to sustainable construction practices, reflecting their distinct economic, environmental, and social contexts. While these countries share common goals of reducing the environmental impact of construction, they face unique challenges and opportunities:

1. **Economic Significance:** The construction sectors in these nations play a vital role in their economies, contributing significantly to GDP and employment. This economic significance highlights the importance of integrating sustainable practices into construction activities.
2. **Concrete Production:** Concrete production is substantial in all four countries, emphasizing the need for sustainable concrete manufacturing. Ready-mixed concrete dominates, with a focus on in-situ concrete, precast concrete components, and various applications. The adoption of recycled aggregates and sands in concrete production varies, underscoring the potential for improving sustainability further.
3. **Construction and Demolition Waste (CDW):** CDW generation is a common concern, with robust recycling infrastructure in France and Germany. Belgium and the Netherlands also prioritize waste separation and recycling. However, the acceptance and utilization of recycled CDW products remain challenges, particularly regarding quality and cost considerations.
4. **Aggregates Production and Consumption:** These countries are significant producers and consumers of aggregates. Despite ample reserves of primary resources, promoting recycled materials over primary resources faces obstacles related to quality and cost considerations. These obstacles are less prominent in regions where natural resources are scarce such as the north of the Netherlands which exhibit very high recycled aggregates usage.