Circular Economy and Waste Markets

Preliminary study of the construction and demolition waste market and its implications for the circular economy

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Preliminary study of the construction and demolition waste market and its implications for the circular economy

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EXECUTIVE SUMMARY

The present report shows the results of a study conducted between February 2019 and June 2019 on the construction and demolition waste market (CDW) in The Netherlands. The study had the objective to dissect the key features of the CDW sector, in terms of policies, governance, volumes and challenges. It aimed at understanding the key research and policy challenges for the reorganization of the waste sector in order to comply with the key ambitions of the circular economy. In this study, the notion of circular economy is defined as the process of overall reduction of waste through the increase of its reuse as close as possible to its point of source. While recycling and secondary materials production remains core part of any circular economy strategy, we see the geographical factors crucial to facilitate the upscaling and repurposing of discarded materials within city-regional economies.

Annually, around 25.000.000 tons of Construction and Demolition Waste (CDW) is produced in The Netherlands, which constitutes roughly 40 percent of the total waste production. Despite this enormous bulk and volume, we can see trucks and containers full of old bricks go by without sparing it a second thought. The question is whether we can permit ourselves such a neglect in light of the environmental problems we face. Concrete production is a large contributor to CO2 emissions, and the main components of concrete: sand an aggregates, are becoming scarcer by the day (UNEP, 2019). A solution could be to reuse CDW in the production of new materials, which is also what we see reflected in increasing policy and private attention for this material stream. This report is an explorative part of a larger research program on the role of the circular economy in changing the waste landscape. As a first step, we try to offer an insight into the world of CDW by discussing key facts, figures, policies and actors.

CDW consists for more than three quarters out of mineral fractions released from construction and civil engineering works such as concrete, bricks, gravel and sand. Then, around 15% is asphalt released from infrastructural projects, the other materials: wood, metals and plastics, are sorted out and taken up in their respective recycling stream (Bijleveld et al., 2014). Around the 1970's all CDW was put into landfills, but with increasing environmental regulation and rising land values, this disposal method became too expensive. More importantly, however, CDW proved to be a good foundation for infrastructural and residential development on the Dutch peaty soil, thereby solving both waste management challenges and providing foundation feedstock. Since then we have seen a rapid increase in recycling resulting 95% recycling of CDW today, see figure 1.

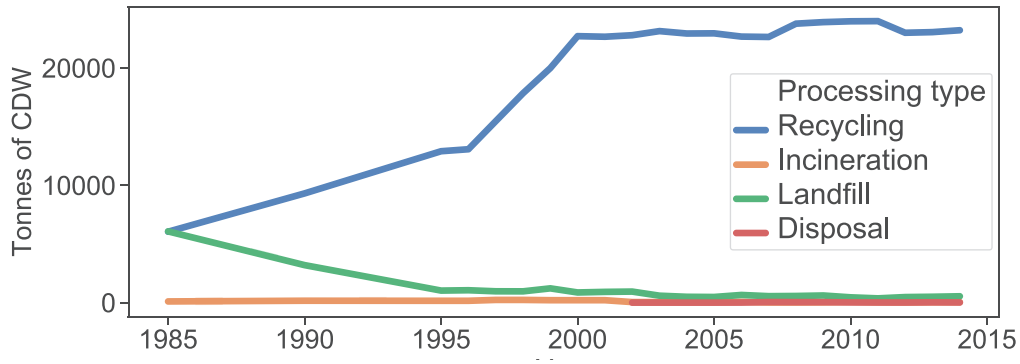


Figure 1. Processing of CDW in the Netherlands, 1985 - 2015. Source: CLO (2019)

When comparing figure 1 with the policy timeline of CDW (see figure 2), we can also see the distinct effect of the landfill tax and prohibition in the mid-1990's which further spurred on for waste management. At the basis of these policies was the influential Ladder van Lansink which favored higher applications (prevention/ reuse) over low tier management (landfill/ incineration).

However, only a very low share of CDW is currently reused in new concrete (3-4%). Consequently, and under the banner of the Circular Economy, certain market players have united under the voluntary agreement "het Betonakkoord" to aim for 100% reuse of CDW in new concrete in 2030. Yet, there are still numerous barriers that limit the circular potential of the CDW sector. An indication is the strong lobby of primary producers on the specific wording used in the covenant, since increasing reuse of CDW possibly threatens the demand for primary concrete.

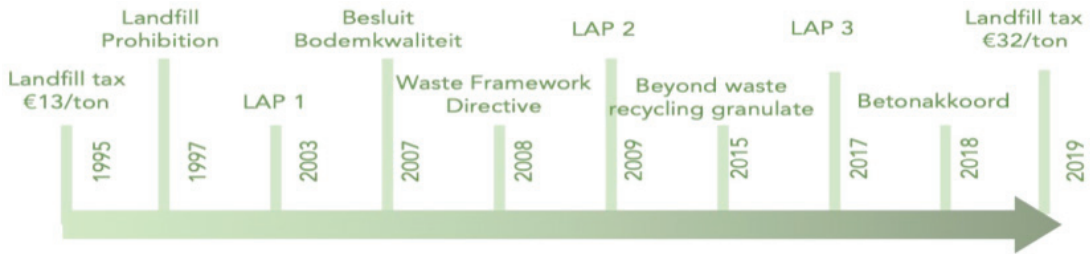


Figure 2. Timeline of CDW regulation in the Netherlands

1 INTRODUCTION

With 25 million tons, construction and demolition waste (CDW) is by far the largest waste stream in The Netherlands (almost 40 percent). This is waste stream, mainly consisting out of concrete has quite a large impact on our world. Concrete production causes lots of CO2 emissions, the exploitation of resources brings along significant land use change, and finally the feedstock, sand and aggregates, is becoming increasingly scarce (UNEP, 2019). Yet, aside from the sheer volume and environmental impact, CDW differs from other wastes such as plastics and scrap metals because it is a very local issue. The high weight and low value seriously limit the mobility of the material and thus management needs to be done in proximity to densely inhabited areas. Nevertheless, the material is rewarded with very little public attention and tons and tons of the material are released from our cities and pass through our streets without being given a second thought.

However, there are indications that this is changing. Since the increasing environmental awareness of the 1990's several policy strategies have been developed, from the Ladder of Lansink (Waste treatment hierarchy), cradle to cradle and now the Circular Economy. Especially these latter two policy strategies try to transform waste from a mere inconvenience into an economic opportunity. The implications for the of such a reconceptualization are still to be determined especially with regard to CDW. This report tries to add to the knowledge on the geography, policies and stakeholder interests by closely looking at CDW-sector in relation to the circular economy.

After this introduction some methodological considerations are discussed on the basis of which this report is written. Subsequently, an overview of the keys facts and figures related to the CDW-sector are presented. Then, important policy measures are discussed, followed by the geography of this waste sector. Lastly, some future avenues for research are sketched out relating to the role of CDW in the circular economy.

Methodological note

This research is the first phase of a larger research program on the geographical impactions of Circular Economy policies and business strategies. Results are based on numerous interviews with stakeholders directly related to the CDW sector, the waste market or waste policies in general. We spoke with members of government private sector companies, and academics. The largest share of information is derived from governmental, consultancy, and private company reports on the construction and CDW-sector. Statistical data is provided by the CBS (Central Bureau for Statistics) and Rijkswaterstaat and the EIB (Institute for the construction sector).

2 THE CDW SECTOR

2.1 Process

Figure 3 by Bilsen et al schematically visualizes the European CDW market, and the material flows in accordance to their relationship to the Circular Economy. In short, brown lines indicate material flows where there are opportunities for industrial symbiosis. In red are the potential barriers for the Circular Economy. Opportunities are in green and purple lines signify international trade flows. Furthermore, the figure shows that there are several phases in the CDW-processing chain, the three most important, generation-, transport- and the processing are discussed below respectively.

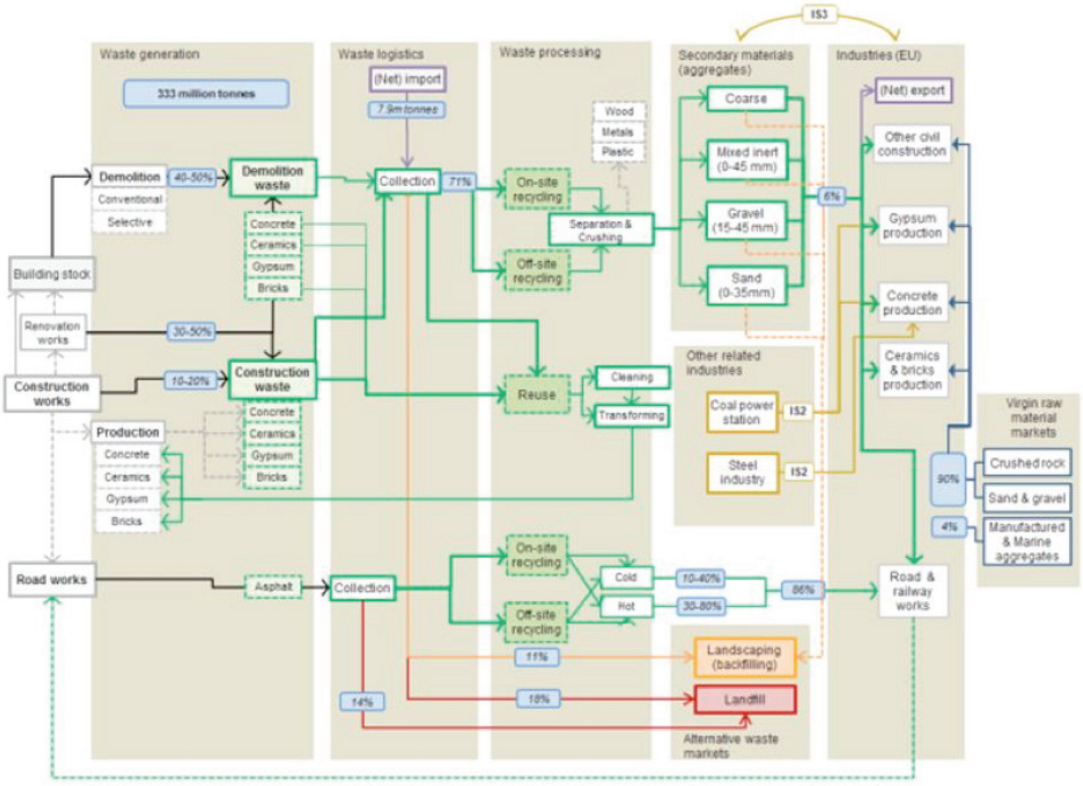


Figure 3. CDW flow chart. Source: Bilsen et al. (2015).

With regard to the generation phase, Bilsen et al. (2015) identify four sources of CDW: road works, renovation, demolition and construction. Exact data on which source is the largest is unavailable, but this is likely to be infrastructural and demolition projects since especially construction waste is (becoming) a limited source of CDW as a result of more efficient construction, e.g. by the use of prefab. The composition of CDW is around three quarters minerals such as concrete, bricks,

soil, see Table 1. Other components of CDW are asphalt (17%) and smaller fractions such as wood, metals and plastics.

Type		**Volume**
Mineral		75%
Asphalt	No tar	17%
	Tar containing	4%
Plastics		<1%
Wood		1%
Metals	Ferro	<1%
	Non Ferro	<1%
	Construction steel	1%
Other		<1%

Table 1. CDW composition. Source: Bijleveld et al. (2014).

The second phase Bilsen et al. (2015) distinguish is the transport of CDW. In this regard CDW is a very local issue because of the heavy weight and low value of the material which make it economically unprofitable to transport it further than 15-25 kilometers over road (Bijleveld et al, 2013). Therefore, large scale demolition projects do not transport their waste to processing facilities but make use of mobile breaking installations to process CDW on-site, after which it is transported by road or water to a facility for further processing or directly backfilled in civil engineering projects. For smaller scale projects such as renovations waste is brought to municipal collection points or private firms.

The last phase that we discuss here is the processing of CDW. Figure 3 shows that only a small fraction of the mineral waste is used for the production of new materials. The majority (95% in NL) of the mineral fractions are used in civil engineering projects as foundation for roads or other large infrastructural projects. The reapplication of these materials in the production of new concrete is quite low, only 3-4% of new concrete consists of secondary materials in the Netherlands (Schut et al., 2015). For asphalt the processing can be costly since it was previously made with tar, which is now categorized as a hazardous material and needs special treatment. After treatment, or when made from bitumen instead of tar, asphalt is often also used in road base material but has the potential for reuse in new asphalt. The smaller fractions of CDW, such as glass, paper, metals and plastics are sorted out and taken up by their respective recycling stream or applied otherwise (e.g. incineration, see Figure 4).

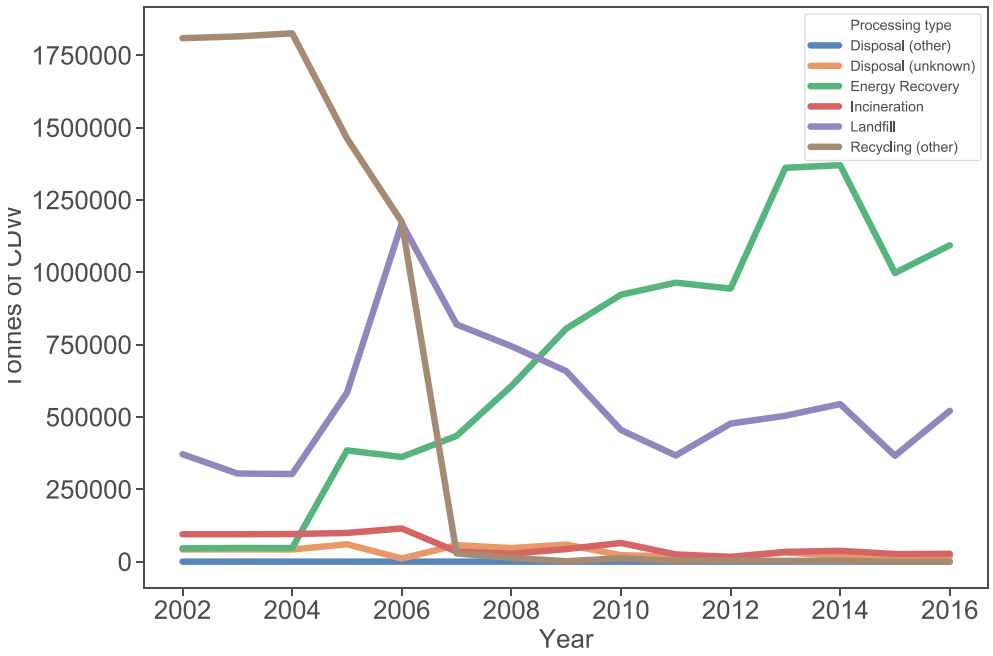


Figure 4. Processing of CDW excluding recycling over the years. Source: RWS (n.d.)

2.2 CDW and the Circular Economy

As said above, only 3 to 4% of new concrete consists of secondary materials which is quite low in light of Circular Economy targets. In addition to the scheme by Bilsen at al. (2015), wherein they identified landfilling as a problematic, this research has found several other barriers limiting the potential of the Circular Economy.

First, not all actors in the CDW-sector are willing to change their business model. For example, despite the fact that CDW processors profile themselves as the pillars of the Circular Economy, they feel little incentive to strive for the reduction of the waste stream overall and the maximum reuse close to source. They earn money by receiving waste (about €15-€10 per ton), and by selling processed CDW in the form of gravel or granulates (around €5 per ton) they can raise and lower prices on either side of the chain. This business model allows them to be resilient to market fluctuations and since competition is not that fierce these companies feel little incentive to change their successful models. Other parties that are more publicly opposed to the Circular Economy are primary material suppliers, who extract sand and other minerals to produce cement and concrete. Hence, the challenge is to reduce the dependency of these business sectors on waste streams so to enable the overall reduction in the demand of primary material.

Besides the interests of stakeholders, the second barrier has to do with technical and logistical challenges. With regard to the latter, there is currently no coordination construction and demolition works. As a result, released CDW in demolition projects needs to be stored to await reuse in future construction projects in its proximity. Thereby, the current model requires one more step (storage) to be added to the logistics of reusing CDW, leading to increased costs. A technical challenge is the sorting of CDW into pure monostreams. Current practices only break mineral fractions of CDW but are not good at separating cement, granulates and sand, thereby hugely decreasing reuse opportunities. However, technologies like the SmartCrusher create the monostreams sand, gravel from CDW. To also sort out the cement fractions is more challenging. To facilitate for better reuse of material it is important that reuse is taken into consideration in the design phase of a building. Hence, it is largely unknown which materials are in a building and particular ways of construction make dismantling into parts almost impossible.

A third barrier is that primary materials such as sand and gravel are literally dirt cheap. Large landscaping projects such as 'Ruimte voor de Rivier" are even increasing the supply of these materials, thereby making it very difficult for reused products to compete on the same market (Schut et al., 2018). Besides that, with regard to regulations there is a barrier that prescribes that primary materials should be used in construction projects and not secondary material streams because waste materials cannot comply to certain standards, but this requirement is likely to be let go off in the future. All in all, the CDW chain is all but straightforward, especially in light of the proposed circular targets which aims to connect demand to supply, favors some market actors while threatening others.

3 HISTORY OF REGULATION

The common practice of landfilling CDW in the 1970's came under pressure as a result of increasing land prices and environmental concerns. Other applications were sought and CDW turned out to be very suitable for application as road base material to strengthen the peaty Dutch soil.

Although this was a welcome development for both project developers and waste management, it also created the need for regulating the quality of this secondary waste stream to prevent soil contamination and exposure to toxins (see Figure 5). One of the first legislations was the ban on hazardous materials such as asbestos in 1993. Despite the ban, the material was still widely present in buildings from construction prior to the ban. When released the material requires very careful processing (current practice: wrapping in plastic and landfilled). More recently, a proposal is done to require all roofs to be asbestos-free in 2024, probably leading to an increase in the amount of hazardous CDW. Another example is asphalt that contains tar which was banned in 1997. Figure 6 shows the share of hazardous waste compared to the total amount of CDW.

Figure 5. A selection of policies relevant to the CDW sector.

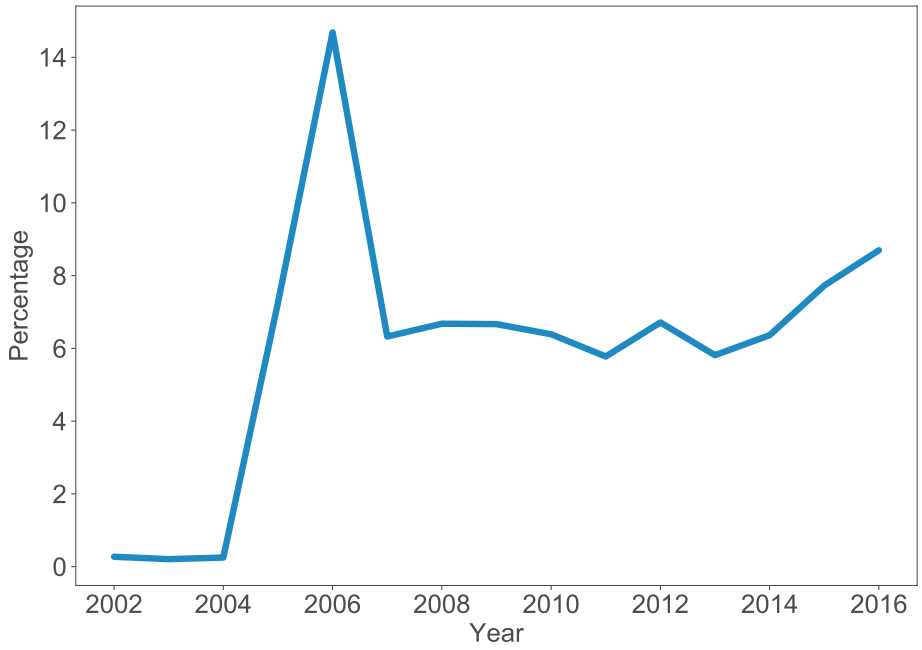


Figure 6. Percentage of CDW that is hazardous waste through the years. Source: RWS (n.d.)

The majority of CDW, however, is not hazardous and had the potential to be recycled. To achieve this a landfill and incineration tax of about €13, -/ton reusable CDW was installed in 1995 and an overall landfill prohibition was installed in 1997 (Bartelings et al., 2005). Figure 6 illustrates that CDW landfilling started to decrease already before this legislation, this can be explained by the high costs and good alternative as road base material. However, as argued by Bergsma et al. (2014) this legislation did have a large influence on the recycling percentage, which is supported by the trend shown in Figure 7. The figure shows that although the amount of CDW increased a lot over the years all this extra material has been recycled, thereby allowing for the amount of landfilled CDW to decrease despite significant increases in overall CDW production. In 2019 the tax was increased to €32,-/ton, possibly leading to even less landfilling.

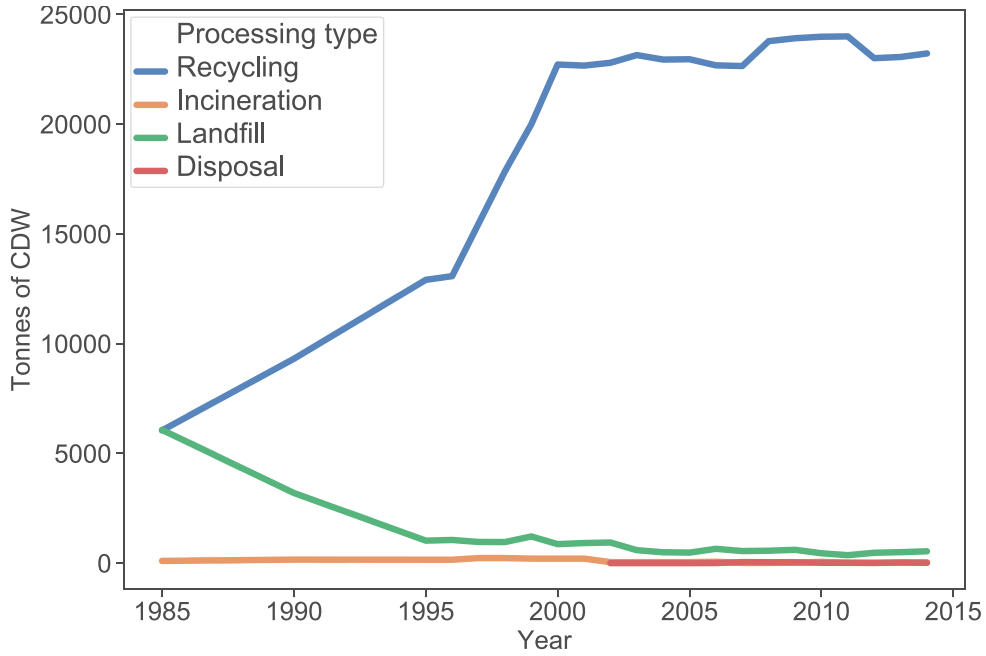


Figure 7. Processing of CDW in the Netherlands, 1985 - 2015. Source: CLO (2019)

A more encompassing approach to waste management was the LAP1 (National Waste Management Plan) introduced in 2003 as part of the Environmental Protection Act (Bergsma, 2014). LAP dictates specific waste management procedures per waste stream with the overall aim to create uniform waste management legislation in all provinces in the Netherlands. Additionally, LAP1 aimed to liberalize the waste market and to achieve high grade recycling. It was in LAP 2 that CDW was targeted specifically by stating that the recovery rate of CDW 95% should remain fixed, in spite of the expected increase in CDW from 24.000.000 ton in 2006 to 31.000.000 ton in 2021. Also, it specified the proper handling of different streams within CDW and set the minimum processing at sorting (instead of direct application), to create as many monostreams as possible to facilitate higher grade recycling. Moreover, in LAP2 the concept of cradle to cradle was introduced in policy. In LAP3 the Circular Economy is introduced, specific to CDW there are little changes except for a re-categorization of tar-asphalt from mineral waste (such as concrete) to a separate stream.

A few years after LAP1 was introduced, a new regulation was installed in 2007 aimed to regulate the reuse of CDW as base material, the Besluit Bodemkwaliteit (BBK, Regulation on Soil Quality). This was an industry led legislation with the aim to homogenize CDW application legislation between provinces and facilitated a more streamlined application of CDW as road base material since it set standards for these materials. The idea was to prevent the use of environmentally harmful substances in construction to be applied to the soil (Schut et al., 2015). Noteworthy is that the primary resource suppliers (sand, gravel, stone) were not in favor of this legislation since they were afraid that demand for primary materials would drop.

Similarly, suppliers of primary materials were also hesitant to cooperating in an initiative that tried to increase the amount of CDW used in new concrete. This voluntary Green Deal Verduurzaming Betonketen started in 2012 and evolved into the Betonakkoord which was signed by private parties and the government in 2018. They set the target of a minimum of 5% recycled content in new concrete starting in 2019, and 100% reuse in new concrete in 2030. Large concrete and cement producers did not sign the agreement at first hand, only after they requested to include a side letter with some controversial statements, for instance on the beneficial nature of resource extraction on biodiversity. Another side note is that current construction standards set the limit at 30% recycled content in concrete used for construction (Bouwend Nederland, 2019).

Lastly, the European Union set the target of "a minimum of 70% (by weight) of non-hazardous construction and demolition waste be prepared for re-use, recycled or undergo other material recovery", which is easily reached in The Netherlands. What is of relevance in EU legislation is that there is being tried to re-categorize certain waste streams as materials. This is because once something gets the label waste it limits the processing opportunities because waste is obliged to be treated in certain ways. An example of this (which is not EU-wide legislation) is the decision made in 2015 to re-categorize recycling granulates out of mineral fractions of CDW not as waste, but rather as a resource, which then allows for more easy application in for instance cement.

4 KEY STAKEHOLDERS

4.1 CDW sector

As shown in the section on the CDW-process, there are a lot of actors involved in the CDW chain such as projects developers, architects, governments and waste processors. The latter are discussed within this section by selecting the most relevant based on interview information (with a slight bias for the Randstad), but first some general information on the CDW.

Even though the demolition sector was one of few players in the 1990's, Table 2 shows that there are quite a lot of smaller companies (247) compared to larger ones (15) in 2013. This can possibly be explained by the fact that many small companies tried to win over some market share around the 2000's. With mobile breaking installations "they were seen in the sector as cowboys", that tried to conquer the CDW market that was little dynamic before. Unfortunately, data is unavailable on the market share per company size, nor does it give an indication of how this has changed through time. Yet, there is data that shows the revenue per company through the years in Table 3 and here we can clearly see that the effects of the crisis mainly affected smaller companies, since their revenue more than halved after the crisis and there are no signs of recovery. In contrast to this, larger companies were able to secure a relatively stable revenue. The consequence could be that the amount of small companies has decreased again because of bankruptcies, thereby shifting the market back to a few large players like the situation before 2000.

Compared to the entire waste market of the Netherlands this centralizing tendency of the CDW-sector would not unique. Since some years large international players have become involved in the Dutch waste market. Although not all focus on CDW (e.g. SUEZ) others have taken up large shares of this sector (e.g. Renewi).

	≤ 10 fte	**11-50 fte**	**≥ 50 fte**
N.o. companies	247	108	15

Table 2. Amount of demolition companies, categorized by the number of employees in 2013. Source: Vrolijk et al. (2014).

N.o. employees	**2008**	**209**	**2010**	**2011**	**2012**	**2013**
≤ 10	1080	900	690	490	480	450
10 - 50	3725	3490	3735	3549	3365	3545
≥ 50	21.430	20.035	16.055	21.995	21.165	20.335

Table 3. Revenue per company (x €1000), categorized by the number of employees in 2013. Source: Vrolijk et al. (2014).

4.2 Stakeholders

Renewi is founded in 2017 through a merger of the Dutch Van Gansewinkel and the British Shanks. The company is very present in the CDW market, especially through its Monostream division Mineralz. This division is specialized in handling polluted and contaminated soils and the recycling of mineral wastes. Unfortunately, Renewi shares little numbers on their market share, yet, they stated that they are the largest CDW processor in the Netherlands and that their Mineralz division is growing particularly strong. Annual report figures on revenue are also of little help since they also include other activities (e.g. household waste collection).

Founded	2017, merger of Shanks & Van Gansewinkel
Employees	4316 (not all in CDW sector)
Sites	107 (not all CDW), of which 47 have recycling machinery
CDW processing	2,4m tons in 2017
Revenue 2017	€1800m (Renewi Group). €200m (Monostream Division)
Activities	Collection, transport, processing, sale aggregates

Table 4. Facts and figures Renewi. Source: Renewi (2019)

Recycling Combinatie REKO B.V. has in total 5 locations over the Netherlands and they process around 22-25% of the total mineral debris produced in the Netherlands according to their own numbers. In 2014, for instance, REKO has received 1.800.000 ton of mineral materials. The main location is at the Vondelingenplaat in Mainport Rotterdam, the primary activity (in which €125.000.000,- was invested recently) is a thermal cleaning facility for tar-asphalt.

Founded	+/- 1990
Employees	78 fte (2014), 120 (2018), 140 (2019)
Sites	5
CDW Breaking installation	1.750.000 ton/year
Tar asphalt cleaning facility	750.000 ton/year
Revenue 2014	€27m
Activities	Processing of CDW and tar-asphalt, sale of granulates

Table 5. Facts and Figures REKO. Source: REKO (2019)

Theo Pouw BV is involved in many steps in the construction chain, as there are also involved in the collection of CDW and production of cement. The history of the company as stated on their website tells a story of growth and vertical integration. Where they started with only the transshipment of CDW and soil they now also collect, break, and produce cement. Recently the company has opened two more concrete production facilities in which they use the 30% CDW they collected instead of primary materials.

Founded	1981
Employees	430
Sites	8
Concrete production facility capacity	250m^3/hour
Tar asphalt cleaning facility	500.00ton/year
Activities	Transport, Processing, sale of granulates and concrete.

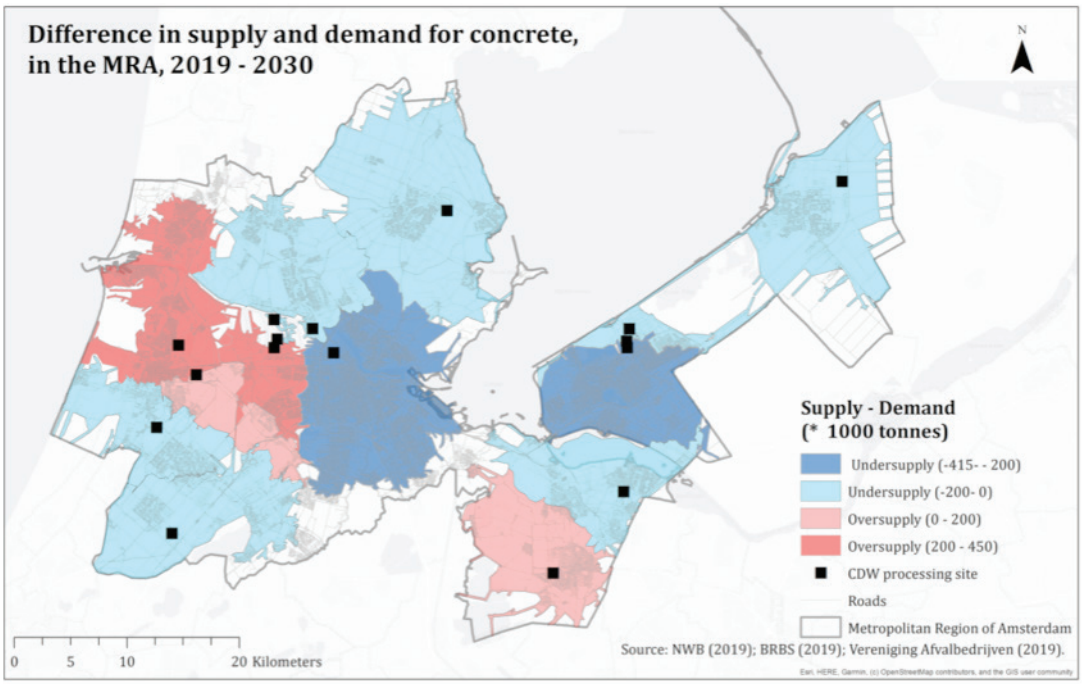
Table 6. Facts and Figures Theo Pouw. Source: Theopouw.nl

5 GEOGRAPHY OF WASTE

Map 1: CDW-sector facilities in the Netherlands. Source: BRBS (2019).

Map 1 shows all the companies that are associated with the Company Association for Breaking and Sorting (BRBS) and does not include facilities not part of this association. Nevertheless, we can see that some provinces and regions are clearly better served than others. Especially Gelderland, Friesland and Groningen have little processing facilities. In contrast, areas such as the Randstad or the province Brabant have a lot of facilities. This can probably be explained by the fact that more urbanized areas produce and require more CDW. Moreover, close to the border in with Germany and to some extent with Belgium, there are also more facilities located. This might have to do with different regulations (e.g. more flexible landfilling regulations in Germany), and the limited mobility of CDW.

Further, a research was conducted on the spatial consequences of the Betonakkoord for the metropolitan region of Amsterdam (see Map 1, Lee Jiaqi & Wildeboer, forthcoming). Based on construction and demolition plans until the years 2030 an estimation was made of the regional differences in supply of concrete waste and the expected demand for concrete waste (5% of new concrete should be of reused material according to Betonakkoord). The map shows that in order to become circular, CDW has to be transported from one region to the other. Given the relative immobility of CDW this creates a significant extra spatial challenge for reaching a circular economy in the CDW-sector.



Map 2. Estimated regional differences in supply and demand for the Metropolitan Region of Amsterdam 2019-2030.

6 OPPORTUNITIES FOR FURTHER RESEARCH

As a result of this research so far I have come up with 4 hypothesis that I discuss below. After that this report ends with a general thought on the incommensurability of the circular economy and the reduction of material use.

1 In contrast to much production industries (e.g. plastics), the entire production and disposal chain of concrete is a national affair. Hence, interests of suppliers of primary materials, the construction sector, and the CDW-sector all interact within the same state, region or city. Consequently, these regions are the interplay of different interests of all these actors. This suggests that Circular Economy has the potential to let these interests clash. For instance, primary producers of sand and gravel may feel threatened by the emphasis on reuse and the inevitable decrease in demand for primary suppliers. Nevertheless, we still see quite a strong push for the circular economy; it is unclear however, stakeholders are behind this. So, this research raises the question who are the potential winners in a circular CDW-sector and who are the losers?

2 Where policy measures before the turn of the century could be regarded as top down and state-led, the last decades there has been a more collaborative form of governance. Emblematic of this are numerous Green Deals in which voluntary agreements between private and public organizations are made with the aim to reduce environmental impacts while sustaining economic growth. An example discussed in this report is the Betonakkoord, which is interesting since it was initiated by private parties and only later picked up by the government. Although, some might be positive of this more collaborative governance that makes way for such corporate responsibility, a critical look might uncover that economic interests are playing a larger role than ever. With respect to the circular economy public private partner ships seem to play a large role, allowing the interests of the people involved in the decision-making process to triumph over those who are not included. So, what are the interests of those involved in pushing for a circular economy? Who are not included in this governance initiated by private parties?

3 The potential of the Circular Economy to alleviate issues of resource scarcity might not seem to be too applicable to the CDW-sector, since sand is not a scarce material. Maybe we have taken sand for granted, since a recent UNEP (2019) report alarmed us of our addiction to sand (18kg/person/day) and the fossil nature of this resource. In contrast to these findings, however, the primary suppliers of sand in the Netherlands demanded in a side letter to the Betonakkoord that it should be explicitly stated that sand was not a scarce resource in the Netherlands. These contrasting statements might indicate that the issue of sand

scarcity could be a very interesting to research (also in Hong Kong!).

4 On the potential of the Circular Economy to decrease environmental impacts, this study suggests that CDW is picked as a priority waste stream for circular policies (as opposed to e.g. plastics or metals) because of the local nature of the environmental impacts. Whereas other waste streams are easily done away with by exporting it to peripheral areas or other countries, the heavy weight and low value of CDW make this impossible and therefore requires us to look for local solutions. Consequently, the need to find solutions for this waste streams are more urgent compared to others because environmental impacts happen close to the urban environments.

5 In light of the environmental and ecological degradation we face the most effective way to combat our negative impact is by simply consuming less. The circular economy may not yet be questioning this aspect. This is not to say that the circular economy cannot accomplish an overall reduction in waste, on the contrary, the circular economy can be very effective in the reapplication of waste into production chains. Rather we can argue that the circular economy is unable to achieve an overall decrease in the amount of materials circulating in the economy, or in other words, to decrease consumption.

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